Autoreferat

1. Name and surname

Dorota Burska

2. Have diplomas, degrees / art - with the name, place and year of their acquisition and the title of the doctoral dissertation

Doctor of Earth Sciences in the field of Oceanography,

University of Gdańsk, Faculty of Biology, Geography and Oceanography, Institute of Oceanography, 2000, *Short-term changes in concentrations of nutrients in the deep-water area of Gdańsk Basin in the spring season.*

MSc of oceanography in the field of physical oceanography,

University of Gdansk, Faculty of Biology, Geography and Oceanography, Institute of Oceanography, 1993, *Short-term changes in concentration of inorganic nitrogen forms in the waters of Gdańsk Deep.*

3. Information on previous employment in scientific / artistic

2011-2015 University of Gdansk, Faculty of Biology, Geography and Oceanology (from 2011 Faculty of Oceanography and Geography), Institute of Oceanography, Department of Marine Chemistry and Environmental Protection, position: senior lecturer.

2000-2011 University of Gdańsk, Faculty of Biology, Geography and Oceanology, Institute of Oceanography, Department of Marine Chemistry and Environmental Protection, position: adjunct.

2007-2014 Kashubian Pomeranian University in Wejherowo, Faculty of Social and Life Sciences, Department of Environmental Protection, position: senior lecturer.

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

a) Title of the scientific achievement

The organic matter in the suspended particulate matter and sediments of the Gulf of Gdansk

b) (author / authors, title / titles of publication, year of publication, name of publisher, reviewers and publication)

A detailed description of my participation in the creation of each of the publications included in the scientific achievement was presented in the list of publications (Supplement 4; I B).

1. Pryputniewicz D., Falkowska L., **Burska D.,** 2002, *Adenosine triphosphate in the marine boundary layer in the southern Baltic Sea*, Oceanologia, 44 (4), 461-473,
2. **Burska D.,** Pryputniewicz D., Falkowska L., 2005, *Stratification of particulate organic carbon and nitrogen in the Gdańsk Deep*, Oceanologia, 47 (2): 201-217,
3. Bradtke K., **Burska D.,** Matciak M., Szymelfenig M., 2005, *Suspended particulate matter in the Hel upwelling region (the Baltic Sea),* Oceanological and Hydrobiological Studies, 34, (Supplement 2), 75-94,
4. **Burska D.,** Szymelfenig M., 2005, *The upwelling of nutrients in the coastal area of the* Hel Peninsula, Stud. Oceanol. Hydrobiol. 34, Suppl. 2, 67-85,
5. Łukawska-Matuszewska K., **Burska D.,** 2011, *Phosphate exchange across the sediment-water interface under oxic and hypoxic/anoxic conditions in the southern Baltic Sea.* Oceanological and Hydrobiological Studies, 40 (2), 57-71,
6. Staniszewska M., **Burska D.,** Sapota G., Bogdaniuk M., Borowiec K., Nosarzewska I. Bolałek J., 2011, *The relationship between the concentrations and distribution of organic pollutants and black carbon content in benthic sediments in the Gulf of Gdansk, Baltic Sea*, Marine Pollution Bulletin , 62 (7), 1464- 1475,
7. Łukawska-Matuszewska K., **Burska D.,** Niemirycz E.,2009, *Toxicity assessment by Microtox; in sediments, pore waters and sediment saline elutriates in the Gulf of Gdańsk* (Baltic Sea), CLEAN - Soil, Air, Water, 37 (7), 592 – 598.

c) Scientific objective:

Introduction

Modern researches of supply and degradation of organic matter in the marine environment relate in particular to coastal waters, heavily polluted and susceptible to eutrophication. The concentration of the organic matter in the water column and bottom sediments of these water reservoirs are usually high due to the direct supply of organic matter from land and high primary production caused by the flow of biogenic salts.

This leads to the intensification of degradation processes and the accompanying transformation of the organic matter. Organic particles degrade while sinking, becoming impoverished in phosphorus, nitrogen and carbon, thereby becoming a source of regenerated nitrogen and phosphorus. The presence of the density barriers limited the sedimentation of organic suspended matter, increases their retention in shallow layers of the sea and improves the circulation of carbon and biogenic elements in the environment. Increased load of the organic matter reaching the sediments, increases the consumption of oxygen in the process of mineralization, which raises the risk and the extent of occurrence of oxygen deficits.

The morphological characteristics of the Baltic Sea are next to several times higher than the natural supply of nitrogen and phosphorus by rivers, an important factor influencing susceptibility of this reservoir to eutrophication. They hinder the exchange of water, hinder the outflow of water and prolong the retention time of the elements, and also limit the possibility to refresh the resources of oxygen in bottom waters.

In the Gulf of Gdansk, considering the distribution of the organic suspended matter in the water column and sediments, besides the intensity of primary production and the density stratification, it is necessary to consider the outflow of the organic matter with the waters of the

Vistula River and hydrodynamic processes. The location of the river hydrological front depend on the flow rate of the river and the speed and direction of the wind. In most cases, in the Gulf of Gdansk, waters of Vistula River are transported towards the east and north-east direction. Transportation of the Vistula waters may also take place along the Hel Peninsula. Under favorable conditions in the shallow coastal zone of this area we can observe upwelling. The area around the peninsula is an area of complicated hydrodynamics, where the transport of marine waters takes place in both directions: vertical and horizontal, which can modify the distribution of the suspended matter and their chemical components.

Researches related to the suspended matter and its qualitative composition provide an information about the transfer of matter between the source and the place where it is deposited. The suspended matter is formed by particles of various shapes and sizes constructed of both the organic matter - in the form of living organisms and the detritus as well as inorganic. These particles are formed in the sea (as a result of biological production, destruction processes of the shore and the bottom or precipitation of the dissolved matter), or are brought to the sea from the waters of rivers, rain or brought by the wind. Natural organic matter of land or marine origin consists of a heterogeneous mix of particles and molecules of different physical (e.g.: size, porosity) and chemical (functional groups, solubility) properties. Changes in the composition of the organic matter in time are represented by the weighted average change in the composition of each component. The mix of such matter is characterized by different circulation times.

The organic suspended matter and its quality is therefore an important element in the circulation of biogenic elements and the identification of factors controlling this circulation belongs to the important scientific tasks. Processes of assimilation and mineralization of the organic matter taking place in a short time scale of hours to days. In the world literature there are not many works on the daily fluctuation of the suspended organic matter in the marine environment. In the 70s of last century, the studies of the daily variation of plankton biomass indicators were led by researchers from MIR in Gdynia. About 20 years later, interdisciplinary studies of short-term fluctuations of physical, chemical and biological parameters in the water column of Gdańsk Deep started Dr. Lucyna Falkowska. Since 1994 I participated in these studies dealing with biogenic substances and oxygen.

The analysis of short-term variability of the organic suspended matter with respect to the boundary layers in the sea, is a continuation of this study. In the assessment of the flow of matter in the aquatic environment, it is important to determine the quantity and quality of matter that reaches the seabed. Streams of organic carbon and nitrogen are then defined as the first of this type of data in the deepwater of the Gulf of Gdansk. The implementation of these researches in the area away from the land sourcea of matter makes it possible to relate the results only to the primary production. A particularly interesting aspect was also to consider the impact of the daily thermocline on the size of carbon and nitrogen retention, particularly in the context of support / inhibition of primary production process during the late spring.

With the increase of the depth, decreasing the amount of the organic suspended matter, increasing: its level of degradation and the concentration of nutrient salts returning to the circulation. Under certain circumstances, can occur an upward movement of waters from greater depths, carrying the degraded matter and biogenic substances to the surface of the water. It may also take place sinking of well oxygenated surface waters containing the "fresh" organic matter. Removing the suspended matter from the surface layer is related to its falling toward the bottom. With the increase of depth, increases the degradation level of the falling organic matter and the biogenic substances are released to the environment. Under the certain conditions, the degraded

suspended matter and released biogenic substances can be surfaced or the water containing the "fresh" organic matter can collapse into the deeper layers. In the stratified, fertile Baltic Sea there were identified several dozens of areas in which a vertical movement of the water can be observed.

One of such areas are the coastal waters along the Hel Peninsula. Coastal upwelling and downwelling are irregular processes with a different intensity, which depends on the strength and duration of the wind. The incidence of both processes in the area of research is high. Additionally, in the vicinity of the Hel headland these phenomena are extremely. Although in the coastal zone these are important processes of vertical mixing, till the implementation of researches described in the following publications, there was no analyses related to the changes in the field of suspended matter and the trophy caused by this phenomenon in the area of Gdańsk Basin. So, the information about the upwelling, as the cause of increased concentrations of nutrients, appeared in the literature on the Baltic Sea (IMGW reports), so there was lack of any information about the impact of this process on the field of the suspended matter.

The stream of the organic matter, reaching the sediment, is the resultant intensity of its sources and processes reducing its quantity during the fall (sinking). The enrichment of marine sediments with organic matter, particularly vulnerable to degradation, intensifies biogeochemical processes, in particular, affects the size and direction of the exchange of chemical substances between the sediment and the water. Previous studies of the exchange of nutrients at the water-sediment boundary related to deep regions of Gdansk Basin, in the areas below the depth of halocline or when the sediments were located within this interbeddings (attachment 4; II A-10). These last areas of the seabed are particularly interesting, because of the possibility of halocline erosion on the contact with the seabed. In the literature on the Gulf of Gdansk, there is no information about the size and the direction of the exchange of nutrient salts at the water – sediment boundary in the shallower areas when the sediments are situated at depths above halocline. Important processes controlling mineralization of the organic matter in the sediments of these areas are: the supply of relatively fresh organic matter, intense dynamic processes (mixing, re-suspension) and the presence of benthic organisms.

In the marine sediments, besides the organic carbon of natural origin, with different degree of degradation is also present the anthropogenic carbon represented by the carbon black. Into the marine environment, this fraction of carbon gets into with the waters of the rivers and from the atmosphere. A characteristic feature of the carbon black is its poor reactivity (not biodegradable) and strong sorption in the case of organic substances. The determination of the carbon black content in the sediment may be important for the description of many processes in the marine environment, including the transport of persistent organic pollutants. This knowledge lets determine the share of permanently deposited organic carbon in sediments, what complement the information related to the balance of this element in the Gulf of Gdansk.

The results, that I presented extend previous knowledge of the organic matter and its main components in the suspended matter and marine sediments. Information on the content of carbon, nitrogen and phosphorus in the surface layer as well as in the vertical profile of sediments of the Gulf of Gdansk are quite well described. Much less available are data on the content of these elements in the sea suspended matter. A significant part of this information has been collected and presented in a monograph *Geochemistry of surface sediments of the Baltic Sea* (e.g.: Burska, 2011; Burska and Graca 2011, Graca et al., 2011; attachment 4, ; II D-6,7,9).

According to the information in Section I B, the achievements which made up my habilitation thesis are contained in 7 publications in journals currently cited in Journal Citation Reports. Their total IF is 5,24, and the point value (according to the list of scientific journals from 2014) by MNiSW is 155.

The results described in these publications are a reflection of progress of my work on the quantity and quality of organic matter in the waters and sediments of the Gulf of Gdansk with particular emphasis on geochemical and physical boundaries in the sea.

Below, there is a description of the scientific goal and the major achievements of each of works included in the scientific achievement. The work was divided into two thematic parts:

a) the quantity and quality of the organic suspended matter in the water - spatial and temporal variability (publications 1-4),

b) the natural and anthropogenic organic matter in the sediments - the areas of deposition and / or release of chemicals, including hazardous substances (publications 5-7).

The evaluation of short-term variability of quantity and quality of organic suspensions in relation to the boundary layers in the water in the area of the Gdańsk Deep present two works:

Pryputniewicz D., Falkowska L., **Burska D.**, 2002, *Adenosine triphosphate in the marine boundary layer in the southern Baltic Sea*, Oceanologia, 44 (4), 461-473, participation 30%

Burska D., Pryputniewicz D., Falkowska L., 2005, *Stratification of particulate organic carbon and nitrogen in the Gdańsk Deep*, Oceanologia, 47 (2), 201-217, participation 65%

In the first article we presented researches related to living organisms biomass that constitutes the suspended matter, and expressed through the concentration of ATP. Samples for analysis were collected mainly in the open waters of the Gdansk Basin but also in the coastal zone of the Gulf of Puck (in the area of Hel). This was done during several days long(3 to 9 days) measurement campaigns, at the beginning of May (1997, 2000) and in the second half of June (1996, 2000). Samples of the suspended matter were always taken from the sea surface microlayer (10 microns) and subsurface waters (15 cm), and only in June 1996 testing also included the water column from the surface (0.5 m) to the bottom (102 m).

The main purpose of this article was to characterize the variability of the concentration of ATP in the open waters of Gdansk Deep. The results were related to the boundary layers in the sea: the water-atmosphere (surface microlayer and subsurface layer) and density layers in the water column: the seasonal and diurnal variable thermocline and constant over a longer period of time halocline. Fluctuations in the biomass of living micro-organisms in suspended particulate matter were considered in the context of the action of sunlight (PAR, UV-B), the selected weather parameters (wind speed, cloudiness, air temperature). The discussion of this variability and the relationship between the above parameters concerned the euphotic layer, in particular the microlayer.

The increased concentrations of ATP in the water column occurred within all of considered boundary layers with the highest values at / below the lower limit of the halocline. Twice smaller average concentration of ATP was recorded at / above the upper limit of the thermocline, which is also the lower limit of the euphotic layer. The presence of the thermal and salinity pycnocline reflected in increased changeability of the analyzed parameter. Particularly high fluctuations of the concentration of ATP (close to 150%) were observed in the upper halocline.

In the euphotic layer changes of the concentration of ATP showed a close correlation with the phase of the day. During the bright time the inhibition of ATP was observed and therefore the lower concentration, which was particularly evident in the sea surface microlayer. Towards the increase of radiation during the day, increase of the concentration of ATP in this layer was observed in the evening and in the dark phase, probably as an effect of the propagation of the heterotrophs. Due to the high variability of meteorological parameters and / or conversion of autotrophs to heterotrophs there were no changes in the circadian cycle of ATP concentrations in the sea surface microlayer and the subsurface water. To the concentration decrease of ATP contributed: increase of wind speed, reduced cloudiness at very low wind speeds and high volatility of UV-B / PAR relation. The largest concentration of ATP was recorded then three meteorological factors occurred in the same time: relatively high air temperature, overcast and low wind speed (up to about 6 m/s). In the euphotic layer the increase of ATP was caused by primary and secondary production and in the case of bottom waters, the presence of heterotrophic organisms involved in the process of mineralization of the organic matter.

The researches discussed in the second article concerned the quantity (SPM, POC, PON, Chl *a*, feo *a*) and quality (POC / PON, POC / Chl *a*, FeO and / Chl *a*) of the organic suspensions. These parameters were considered: in time (daily variations) and in the vertical profile. An important task, which implementation I have undertaken in the course of the work at sea, was to determine the size of the vertical jets of organic carbon and nitrogen reaching the different levels of the sea and to the bottom. I used sedimentation traps for that purpose. In the Polish zone of the Baltic Sea this type of research is fragmented and pending the publication of this study concerned only the total amount of matter reaching the seabed.

The research was conducted with high frequency, for 10 days at standard depths on the ORP Copernicus. The collection of such a large amount of material was possible thanks to the work of a large team, including doctoral students and students of the Oceanography. During the trip, I placed double sedimentation traps at five levels (1.5, 15, 30, 70, 95 m), taking into account the thermohaline structure and location of the boundary layers in the sea. Based on the material collected in daily and half-daily traps I calculated streams of POC and PON.

The studies let to prove that, in late spring in open waters of Gdańsk Basin the organic matter (SPM, POC, PON) was characterized by the variability from about 20% to 40% at individual depths. The highest fluctuations in these parameters occurred in the thermocline and haloklinie. With depth increase the typical decrease of POC and PON concentrations were observed as well as an increase of the organic matter degradation. The molar ratio of POC to PON, which allows to assess that process, achieved the highest value at the upper limit of the halocline. I found that variations in the suspended matter, in particular in the euphotic layer, was daily by nature in reference to both its quantity and quality. In that course I observed among others, the alternate occurrence of Chl *a* and feo *a*. High concentrations of Chl *a* occurred in the morning and evening hours. A high proportion of feo *a* / Chl *a* with a simultaneous increase of POC / PON ratio I observed at night and noon, which pointed to the intensification of degradation processes of organic matter at this time. At night, in the surface layer, the suspended matter was depleted of nitrogen in the same range as the suspended matter from a depth of about 70 m.

Sediment traps were placed in the 12-hour cycle, although at that time the day was over 4 hours longer. The sedimentary material from the "day" trap did not cover the entire bright cycle, and the material from the "night" trap was increased by an additional material. For this reason, I could not really clearly indicate the difference between day and night, both in quantity and quality of the matter transported towards the bottom. However, in almost 65% of the results

overnight fall of POC was more intensive (even 1.5 times) than in the daytime. In the case of PON I watched exactly the opposite situation.

I calculated that during the period of the research, the PON fluxes were 5 to 20 times smaller than the POC streams that fluctuated from 0.1 to 2 g m^{-2} d^{-1}. I estimated that averagely 28% to 40% of carbon and nitrogen degrades in the 15-meter deep surface layer per day. This indicates that the nitrogen is 12% more efficient mineralized than the coal. The preferential removal of the nitrogen in relation to the carbon occurred from the surface to the bottom, with the highest intensity of that process at night above the thermocline. The amount of organic matter carried out from the euphotic layer was affected by the thermocline - its strength and position. During the researches I observed among others, the appearance of secondary thermocline at a depth of 5 m. It limited the transport of suspended matter below this interbed. This resulted in an average of two times higher concentration of POC and PON in a trap located at a depth of 1.5 m than in previous days and at the same time in0020reduction of the matter stream in the trap placed deeper.

The impact of the coastal upwelling on the distribution of the organic suspended matter in the water column in relation to the seasonally variable thermal stratification and the growing season is presented in two subsequent articles.

Bradtke K., **Burska D.,** Matciak M., Szymelfenig M., 2005, *Suspended particulate matter in the Hel upwelling region (the Baltic Sea),* Oceanological and Hydrobiological Studies, 34, (Supplement 2), 75-94, participation 30%

Burska D., Szymelfenig M., 2005, *The upwelling of nutrients in the coastal area of the* Hel Peninsula, Oceanological and Hydrobiological Studies, 34, (Supplement 2), 67-85, participation 50 %

The evaluation of the variability of trophic conditions and the amount and quality of organic suspended matter in the area of upwelling I conducted on the basis of the research material collected during the growing season in 2000-2002 under the project led by dr hab. Maria Szymelfenig. The subject of the study were columns of water collected: in the center of upwelling, in a transition zone and outside the area of upwelling impact, at the reference station. Commencement of field work was preceded by a determination of the date of occurrence, duration and location of the center of upwelling (meteorological parameters, hydrodynamic model, satellite pictures of the sea surface temperature). 7 cruises took place, during which an upwelling of water from the deeper layers of the sea to the surface layer was observed.

In most cases, the upwelling station was located not more than 1-2 km from the coastline. However, the location of these events along the Hel Peninsula was changing. The research was conducted twice in the area of Władysławowo and Jastarnia and 3 times in the area of Chałupy. Three times we studied the upwelling in summer (July and August), and twice in spring (April, May) and autumn (September). Because of the strong seasonality in nutrients concentrations, oxygen and the concentration of the suspended matter in the Gulf of Gdańsk, the results were considered according to the seasons, in which measurements were done. The IMGW monitoring data related to the southern Baltic waters showed, that conditions, that could affect these parameters (within the research area), revealed no significant differences in 2000-2002. Therefore, annual changes were omitted.

In order to distinguish water masses of different characteristics of the suspended matter as well as the different trophy, the data of each voyage were statistically analyzed. Classification was

based on the statistical grouping method according to Ward's algorithm. In analyzed periods three classes of suspended matter (except 28.08.2002) and three chemical classes were separated. The biggest differences typically related to the Class 1 - "*upwelling waters*" and the Class 3 - " *surrounding waters* ".

The aim of the first of the articles was to determine quantitative differences (total suspension, suspended carbon and organic nitrogen, chlorophyll *a*, the number of particles) and qualitative differences (POC/PON, POC/Chl *a*, the average size of particles) of the suspended matter in water with different thermal-salinity characteristics.

As a result of the research I conducted, I found that in the open waters of the Gulf of Gdańsk, along the Hel Peninsula, the concentration of the total suspended matter was in a typical range of values for the coastal zone of open waters, and suspended organic carbon constituted, on average 30-40%. The POC concentration value was in a fairly wide range from less than 0.1 to nearly 2.5 mg dm^{-3}, and the highest concentrations of this parameter was noticed in surface waters at the reference station. Values of this order were considered more common for the inner waters of the Gulf of Gdańsk (especially in the water propagation area of the Vistula river) than in the open waters of the southern Baltic. Meanwhile, the lowest concentration of POC (dominant in the center of upwelling) during the growing season I observed earlier only in the Gdańsk Deep intermediate waters (30-50 m). Such low values of POC concentrations (<0.1 mg dm^{-3}) in the surface layer occurs only in open waters in winter. An upwelling of water near the Hel Peninsula may therefore come from the "poor in the suspended matter" intermediate layers from deeper areas of open waters of the Baltic Sea.

The researches carried out allowed to prove that in the area, where the upwelling of waters from deeper layers occurs, we can observe the local reduction in mass and numerical concentration of : the suspended matter, the suspended carbon and the organic nitrogen. How strong is this decline, depends on the strength and duration of the phenomenon, its location along the Hel Peninsula and the seasonal variation of concentrations of suspended organic matter. The biggest differences in the concentration of suspended matter I observed in the summer (July and August) when the outer surface waters were rich in phytoplankton and detritus still remained after spring bloom. The presence of a strong thermocline in this period limited the fall of particles, counteract the stirring of water and vertical movement of suspended matter. Therefore, the upwelling of water was relatively poor in suspended matter. Another situation I observed in the autumn.

Concentrations of suspended matter in the place of upwelling were similar or even slightly higher than in the surrounding waters. At this time, fading thermocline favored mixing of the water and falling of the particles. Their balanced concentration I observed in almost the entire water column of the reference station. Then, the difference in the upwelling of waters may be small. Another explanation of this situation may be the appearance of early bloom as a result of upward movement of nutrients to the surface layer (especially nitrates and silicates). In September 2000, in the center of upwelling occurred a concentration of phytoplankton, dominated *by Coscinodiscus granii*, which is typical for October and November.

In the thesis I presented also the changes in the quality of organic matter. In the growing season, in the field of research, the level of degradation of the organic matter (molar ratio POC / PON) reached values from a wide range from 5.1 to 14.8. The most degraded suspended matter I noticed on 13.05.2005 in the whole column of the upwelling station and in the deeper waters of the reference station. In that time the upwelling was located the closest to the Hel headland, in the area where the bottom fault is located, and the depth quickly drops to over 60 meters. It seems to

be likely that, the upward movement of the water was carried out along the slope from an even deeper areas of the Gulf of Gdańsk. Such high, and even higher proportions POC / PON I noticed during earlier researches of short-term volatility of suspended forms of these elements in the waters of Gdańsk Deep. Depleted matter of nitrogen (POC / PON> 17) I noted then in surface waters at night as well as in deeper waters from 30 to 90 m.

The ratio POC/Chl *a* and POC/PON changed from season to season both in the surrounding and upwelling waters. In the surface layer of the reference station the POC/PON ratio showed typical seasonal course of changes, with the lowest values in early spring and autumn (~ 7) and risen values in the summer. The value of this ratio above 8 during the summer is the result of intensive mineralization of organic matter supported with a higher water temperature and the process of photo degradation. The ratio of POC / PON in the waters moved towards the surface was higher than in the surrounding waters in April, May and early August, lower in July, late August and September.

The aim of the next article was to determine the concentrations of nutrients and oxygen in the area of presence of upwelling and downwelling. These are irregular events of varying duration timing (during the year) and different location. The data obtained are the first of its kind in the southern part of the Baltic Sea. While discussing the results, some comments should be taken into account. Firstly, the number of stations and their location, were not always adequate to fully describe of the phenomenon. There was observed among others, lack of similarity between the deep waters at the reference station and waters moved upwards to the surface, that suggested the movement of waters from a different direction than previously assumed. The upward movement of water took place close to the mainland, which could have been an additional source of analyzed substances. Despite these reservations, certain regularities were observed.

The oxygen concentration differed between the studied areas, however, the direction of change was variable over the time. Till the early August, the concentration of oxygen in the waters moved upwards was lower than in the reference region, and till the end of August, the situation was reversed. This was due to differences in solubility of oxygen in water at different temperatures as well as the intensity of the primary production. At the same time waters being moved upwards to the surface never were permeated and the lowest oxygen saturation (<75%) in these waters was recorded in the second half of September.

In the surface layer at the station located in the center of upwelling, concentrations of nitrates, ammonia, phosphates and silicates were usually significantly higher than in surface waters at the reference station. The water moved upwards to the surface was richer in phosphorus and silicon as compared to nitrogen. Significantly higher phosphate concentrations were observed when upward movement of water held closer to the Hel headland. In this area, waters are likely to be moved upwards of even greater depths than 60 meters. In this waters, the concentration of nutrient salts and proportions in which they are present, depends on the variable intensity of mineralization of organic matter and oxygen conditions.

During the research conducted in May, a very high levels of phosphates, reaching 6 μmol dm^{-3} in surface waters at the upwelling station and 1.1 μmol dm^{-3} at the reference station were noticed. The upwelling center was seen then very close to shore, as well as the distance between the researched stations was small. High concentrations of phosphates in surface waters around Hel Headland are not uncommon. In April 2014 at the monitoring station (ZN4), located close to the place where I conducted the researches, in subsurface waters were observed phosphate concentration of up to 1 μmol dm^{-3}, and at a depth of 20 meters concentration of this ion was not even 2 times higher. Such high concentrations of phosphates may indicate that the water came

from higher depth and could be a result of the strong mineralization of organic matter after a spring bloom of phytoplankton. This process was not supported with oxygen, which diffusion was not limited with created just thermal stratification. A high concentration of the heavily mineralized organic matter (C/N>14), together with a high level of nutrients, was found only during the event.

The second part of the scientific achievement is related to the natural and anthropogenic organic matter in the sediments of Gdansk Basin and its role in the release of chemical substances from sediments, including hazardous substances.

Łukawska-Matuszewska K., **Burska D.,** 2011, *Phosphate exchange across the sediment-water interface under oxic and hypoxic/anoxic conditions in the southern Baltic Sea*. Oceanological and Hydrobiological Studies, 40 (2), 57-71, participation 40%

Staniszewska M., **Burska D.,** Sapota G., Bogdaniuk M., Borowiec K., Nosarzewska I. Bolałek J., 2011, *The relationship between the concentrations and distribution of organic pollutants and black carbon content in benthic sediments in the Gulf of Gdansk, Baltic Sea*, Marine Pollution Bulletin , 62 (7), 1464- 1475, participation 40%

Łukawska-Matuszewska K., **Burska D.,** Niemirycz E.,2009, *Toxicity assessment by Microtox; in sediments, pore waters and sediment saline elutriates in the Gulf of Gdańsk* (Baltic Sea), CLEAN - Soil, Air, Water, 37 (7), 592 – 598, participation 40%

The main objective of the first of this series of articles was to determine differences in the stream of phosphates at the water-sediment boundary between oxygenated coastal sediments and constantly hypoxic or anaerobic sediments in the deep sea area. The research was conducted in spring and autumn in 2005 and 2007-2010 in the southern part of the Baltic Sea. Streams of phosphates were appointed at 11 stations with different depths, different hydro-chemical characteristics of bottom waters and thermal salinity regime. Additionally, in the selected oxygenated and anaerobic sediments I determined its water content, the content of organic carbon, total nitrogen and phosphorus forms.

Based on the TS diagram of bottom waters I distinguished two areas. In the first of them were deep stations of 55 -70 m, in which the water near the bottom was characterized by salinity less than 10 PSU and the temperature below 7°C. Stations were located in the vicinity of Hel headland. The shallow station (50 m) with a salinity typical of the first group, but with a much higher temperature, reaching 16°C, I chose in the waters of the open sea. In the second area includes three stations from the area of the Gdańsk Deep, one of its western slope, and two stations in the deep part of the Gulf of Gdansk, one on the western and one on the eastern side. The waters near bottom at these stations had the salinity higher than 10 PSU and the temperature above 6 ° C. Hypoxia or anoxia I observed only in the deepest waters, below the halocline. With the exception of the eastern part of the Gulf of Gdansk where the phosphate concentration in the bottom waters exceed 20 $\mu mol\ dm^{-3}$ and the others were from 3 to 10 times smaller.

To estimate phosphate streams at the water-sediment boundary we made use of the first Fick's law or the method of sediment core incubation. The first way assumes that the exchange of chemicals mainly affects molecular diffusion. This gives the most reliable results in the case of sediments from the deep waters, where the bottom waters and sediments are anaerobic, and the impact of benthic organisms and turbulent diffusion is limited. Therefore, the most reliable are streams for sediments located at depth > 100 m. In other cases the streams may be underestimated.

At shallower stations (<65), at which the benthic fauna was found in order to evaluate the stream of phosphates, the sediment cores were incubated.

Fluxes of phosphates in the Gdańsk Basin showed strong spatial heterogeneity. I found clear differences between shallow and deep areas. The highest, reaching tens of μmol m^{-2} h^{-1} phosphate streams from the sediment into the water was noticed in the case of shallow sediments (<70 m). This high flow of phosphates into the water was associated with a high rate of mineralization of the organic matter and rapid circulation of phosphorus due to the presence of macrofauna and increased intensity of the hydrodynamic processes. In the open sea, rapid circulation of the organic matter under aerobic conditions and also at a higher temperature results in the removal of P from the organic sediments. For this reason, sediments are poor in organic phosphorus, which reflects a high proportion of C:P in the detritus. The predominant compound of phosphorus in this sediments is phosphorus bounded to calcium, a form of phosphorus typical of the shallow area with well oxygenated water near bottom.

In the shallow sediments located on the border of the Gulf of Gdansk and the Gulf of Puck we observed a situation in which the phosphate concentration in the bottom waters was reduced as a result of this ion collection by sediments. Benthic organisms were most likely responsible for that process, disturbing both: structure and chemical composition of sediments. The activity of Macrofauna, among others, increases the penetration of oxygen in the sediments, and thus it increases the accumulation of the phosphorus in the sediments. Lowering of the phosphate concentration in the bottom waters may be the result of the hydrodynamic processes. There are strong upwelling and downwelling processes along the Hel Peninsula. It may cause that, the phosphate-rich bottom waters are replaced with surface waters with lower concentrations of phosphate. This may stimulate the exchange at the water – sediment boundary, resulting in impoverished sediments of this compound.

The streams of phosphates from sediments located at the transport and accumulation bottom were even several times lower than streams from shallow waters sediments. The low PO_4^{3-} stream of these sediments was probably caused by long-term exposure to hypoxic or anoxic conditions and caused the exhaustion of phosphorus forms, which are available under redox conditions, such as loosely bounded phosphorus and phosphorous bounded to iron. Sediments in the deep areas of the Gdansk Basin are depleted of labile organic phosphorus form, that is bounded to the fresh autochthonous organic matter. A significant depth and density stratification of this waters causes prolongation of stay of suspended particulate matter in the water column and removal of organic forms of phosphorus from the suspended matter in the degradation process.

However, in the organic matter accumulated in this sediments I observed the low ratio of C:P, that indicating a surplus of organic phosphorus. However it was phosphorus in the form, which is resistant to degradation, refractive. The high share of refractive form Org-P in sediments of the deep area of the Gulf of Gdańsk may be partially explained by the addition of the organic matter of terrestrial origin. This matter is more resistant to degradation by microbes than the matter of sea, and in addition can be enriched with anthropogenic compounds of organic phosphorus. The results presented in the publication complements the knowledge about the role of the shallower areas, in which on the processes of chemical exchange between the sediment and water affects also organisms (bioturbation and organic irrigation) and increased dynamics (e.g. mixing to the bottom, moving warmer waters in the deeper parts of the basin, re-suspension).

The quality of the organic matter presented in sediments determines the size and direction of chemicals at the water-sediment boundary. The next two articles relate to the participation of the carbon black (the anthropogenic organic carbon) in the organic matter, which is deposited in

sediments. The important properties of carbon black are: lack of reactivity and strong sorption properties.

The first study on black carbon content in the sediments of the Gulf of Gdańsk I realized in April 2007. In sediments, besides to the black carbon I marked also the organic matter content (LOI) and total carbon (TC). There were also collected samples for analysis of two compounds from the group of persistent organic pollutants: polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). We also performed the granulometry of sediments to confirm that the sorption of organic substances are responsible finest particles of sediments.

The sediment cores in which the above parameters were examined, were collected from the coastal zone, which was under influence of heavy anthropopressure. It was taken into account the sandy sediments from the Port of Gdynia and from the place of storage of excavated material dredged from the port channels and approach channels to the port (Gdynia dumping ground). Other stations were located in the area where the deposition of muddy and clay sediments is possible. The shallower part (60-75 m) was represented by sediments located from the mouth of the Vistula river towards the east and the deeper part (>100 m), sediments from western part of the Gdańsk Deep. Taking into account the conditions of the thermohaline stratification of the Baltic Sea waters, sediments of the shallow stations were located at the depth of upper limit of the the halocline. Below this barrier only the station on the Gdańsk Deep was located. The presence of a strong halocline affects the oxygen conditions below this layer, and these oxygen conditions affect the deposition or release of chemicals from the sediments.

The main purpose of my researches was to identify the contents of BC in the sediments of the Gulf of Gdańsk, determine the areas that are enriched in this form of organic carbon. It was also important to determine whether there is a relation between the content of BC and the studied parameters in the sediment.

Based on the obtained results have indicated that the impact on BC content in bottom sediments of the Gulf of Gdansk, material transport plays, carried the waters of the Vistula and the conditions of its sedimentation. BC concentrations in sediments significantly increased with increasing distance from the mouth of the Vistula, to a greater extent towards the east than the north, with the change of the bottom of transportation to accumulation. The share of BC in the total carbon in surface sediments grew from about 12% in the sediments opposite the mouth of the Vistula to 15% in the muddy sediments in the north-east. Muddy sediments in the area of Gdańsk Deep characterized by a lower share of the BC in TC than in the eastern part of the Gulf of Gdansk.

Differently presented sandy deposits in the Port of Gdynia and at the Gdynia dumping ground. In this case, the share of BC in the TC, in sediments reached even the level of 40%. A strong correlation between the content of the BC and persistent organic pollutants (PAHs and PCBs) was observed for this sediments. This relation was stronger than observed in other sediments. It can therefore be concluded that in these areas mainly the anthropogenic organic carbon leads to purification of the water column, absorbing organic pollutants. Confirmation that BC was responsible for the sorption, was also lack of relation between the share of the finest sediment fraction and PAHs and PCBs in the case of sandy sediments. This is related to the particle size of BC, which are often in the size range of 0.125 - 0.063 mm and 0,250-0,500 mm than below 0.063 mm.

Another possibility is the lack of labile organic matter in the sediment, which would fill adsorption centers on carbon black. Based on the analysis of the correlation between the organic matter and the content of POPs, it was found a clear impact of its quality and quantity on the

strength of this relation. In the area where I conducted the research very different matter reaches the sediment. As a result of the flow of nutrients in the distribution area of the Vistula waters we can observe a strong primary production, also the terrigenous organic matter arrives here with freshwater, including humus and carbon black. Due to the salinity gradient, there comes to the flocculation and precipitation of organic molecules in this area. It may therefore come: – to sorption of a part of POPs on humic and fulvic acids, despite the fact that carbon black is a thousand times better sorbent, – to seizure the sorption centers on the carbon black by a labile organic matter or – to selective sorption on the organic matter, which results from the construction of POPs. At the same time there is a selective, resulting from the construction of POPs, sorption of organic matter (stronger relationship between the different organic matter than PAHs and PCBs).

The results, indicating a significant correlation between soot and the content of POPs in sediments of the Gulf of Gdańsk, caused that I continued my research on the content of the anthropogenic forms of organic carbon and its role in the marine environment. An important task of researches carried out was also to determine the toxicity of sediment and determine whether there is a relationship between the amount and quality of organic matter in sediments and chemical composition of interstitial and bottom waters. To determine the toxicity of the sediment the Microtox tests were used. The results of measurements of toxicity of sediments are an important indicator describing the status of aquatic habitats. The toxicity of many chemical compounds is unknown, often it is an effect of antagonistic and synergistic interactions of the various components presented in the sediment. The bioavailability of these compounds can vary with environmental conditions. In this case, the analysis of the individual substances may not reflect the environmental risk caused by the chemical composition of the sediments. Hence, the attempt to assess the overall toxicity of sediments of the Gulf of Gdańsk.

The research took into account the sand sediments located closer to the shoreline. These were the sediments in the vicinity of the mouth of the Vistula River and located on its eastern and western side, between isobaths approx. 20-30 m. I collected also sediments from the western part of the Gulf of Gdańsk, from stations located on a promontory profile Hel - Depth of Gdańsk (between isobaths 60 and 100 m). I took into account two-centimeter thick layer of surface sediments. The selection of stations was not random, chosen area is a place of occurrence of the upwelling and downwelling phenomenon as well as a second output (apart from the eastern one) of the Vistula waters from the Gulf of Gdańsk. The previously described works showed a significant role of dynamic processes which supports processes of chemicals removing from the sediment and bottom waters and moving it upwards to the sea surface in this area.

In the area of the research only in the deepest stations, in the bottom waters occurred the oxygen deficiency. Sediments were characterized by varying the total carbon content, according to earlier knowledge from low values (<0.7%) in sandy sediments to high (over 7%) in the area of Gdańsk Deep. Also, the degree of degradation of matter described by C/N ratio was variable from a value of about 10 in the area of deep water to the value, that indicates the significant depletion of sandy sediments in nitrogen, with a maximum of this ratio above 30 in the sediments on the western side of the mouth of the Vistula. In the case of these sediments, it would indicate favorable conditions for mineralization of organic matter.

The highest content of BC I noticed in the sediments located in the western part of the Gulf of Gdańsk. This was almost twice higher value than in the deepest part of the researched area, both: in these and in previous studies. The share of BC in the total carbon content decreased from 35% around end of Hel to 13% in the western part of the Gdańsk Deep. Comparing the

previous results in the deepest part of the Gdańsk basin, both: the amount of BC in sediments and the share of this form of carbon in the TC grow from west to east. More than 20% share of carbon black in the TC was also observed in the mouth of the Vistula river, but the highest (nearly 40%) share I noticed in the shallow-water sediments on the east of this station. In the case of sediments from the mouth of the Vistula river and station near Hel, the increase of BC share in the TC may be related to intense dynamic processes (e.g. waves) that cause resuspension of sediments. As a result, the labile organic matter is degraded and unreactive carbon black remains in the sediments.

A strong correlation between the content of carbon black in the sediments and its toxicity was found. This correlation is significantly higher than correlation between the total carbon and the toxicity. There was also demonstrated a relation between a labile part of organic carbon and toxicity of the eluate, suggesting that the degradation of this fraction of organic carbon may cause desorption e.g. of POPs. At the areas, where we have a large share of the labile fraction of carbon in favorable conditions (e.g. providing a warmer and more rich in oxygen waters) may result in the release of earlier adsorbed organic pollutants. In this way, organic pollutants are joined again into circulation in the water column.

The most toxic sediment proved the sediment from the station located north of the Hel headland, it was twice more toxic than sediments from the station located within the western part of the Gdańsk Deep and 5 times more toxic than sediments collected near the Hel headland. The toxicity of sediments from this region was higher than in the sediments of the Vistula and the port. It was found out that from among of sandy sediments only these, that were taken from the western part of the inner Gulf of Gdansk, were not toxic. The situation was different in the case of pore waters. The pore waters from: the Gdańsk Deep, the foreground of the Vistula and from the area on west of it, proved to be toxic,. In the case of eluates of sediments the toxicity showed only sediments from the areas which are under the direct influence of the waters of the Vistula River and on the west. The rest of sediments were characterized by a low toxicity in this regard.

The main conclusions from scientific achievements

1. I recognized the short-term changeability of concentration of organic suspended matter in the open waters of the southern Baltic Sea in late May and early June. I determined the impact of density, thermal and salinity stratification on: concentration of suspended carbon and organic nitrogen, the degree of degradation of the organic matter as well as the quantity and quality of matter that reaches different levels of the sea and the seabed. I identified how big is the difference in the retention of organic carbon and nitrogen in the euphotic layer with regard to the role of the daily and seasonal thermocline in this process. I indicated that the organic carbon during this period is removed by sedimentation greater than the nitrogen in the entire water column with a maximum above and below the thermocline and (ii) at night.
2. I recognized distribution of the suspended organic matter and biogenic elements in the zone of the coastal waters along the Hel Peninsula. I proved that in the area of research, the upwelling process affected the variability of these parameters in the water column. I determined, that in the upwelled water quantity and quality of organic suspended matter as well as the concentration of nutrient salts and the proportions in which these compounds occure, depend on: the growing season, the development of thermal stratification and the location of upwelling. I observed that in relation to the surrounding waters, the upwelled waters were poorer of the suspended matter in spring and summer and a little richer in autumn. I found that the concentrations of nutrients have always been higher in the center of upwelling, and the water moved upwards were richer in phosphates and silicates than in the dissolved inorganic

nitrogen compounds. At the same time I indicated, that the shape of the seabed in the area of the Hel Peninsula is important for shaping of the field of the suspended organic matter and nutrient salts. With the approach to the end of the Hel, when rising slope of the seabed, waters are lifted from larger depths of the Gulf of Gdansk. In the deeper waters the nutrient salt concentrations are high due to the mineralization of the organic matter and the proportions in which they occur are dependent on variable oxygen conditions.

3. I added information related to the magnitude and direction of flows of phosphates on the water-sediments boundary in the Basin of Gdansk. I found that the sediments of the studied, shallow zone of the sea (<70 m), in which the benthic organisms are present, may change its role depending on the season. In the spring delivery of the fresh organic matter and its mineralization in good aerobic condition generates a stream of phosphates into the bottom waters. In the autumn the sediment absorbed phosphates and responsible for this was probably the high activity of benthic organisms, which oxygenated the sediment and thus increasing its capabilities of phosphorus accumulation. In sediments located below the halocline, I noticed, that due to the long occurrence of anoxia / hypoxia conditions, the sediments were depleted in phosphorus forms dependent on the redox conditions (P adsorbed and bound with Fe) - hence the streams of phosphates from sediments to bottom water were low.
4. I discovered and documented changes in the content of carbon black (CB) in the surface layer and the vertical profile of sediments of the Gulf of Gdańsk. I determined, that in most sediments share of this fraction of the organic carbon in the total carbon represents over a dozen percent. I pointed out that the sediments enriched in carbon black (> 20%) are both: close to the source of that pollutant (at the mouth of the Vistula River, port sediments), and also are presented at a distance from them (north-western part of the Gulf of Gdansk). I determined that for this state of affairs may be responsible hydrodynamic conditions: transporting the carbon black in these areas from various sources and favoring its sedimentation and / or removing the labile organic matter from the water column (ocean currents, upwelling, downwelling, distribution of the Vistula waters, re-suspension). I described the typical size of the carbon black particles, and tied its content with the presence of toxic organic pollutants and high toxicity of sediments. I pointed to the possibility of using this form of anthropogenic organic carbon to describe the transport of pollutants in the sea. In the Gulf of Gdansk, I indicated a place characterized by extremely high toxicity of sediments and high content of anthropogenic organic carbon in it. This region is a potential source of secondary pollution of marine waters with toxic substances.

Scientific plans

In the near future my scientific work will still be associated with the circulation of carbon and biogenic elements in the water column and in the sediments. Currently I conduct three research topics. The first, determination of the size of the carbon black stream to the bottom of the different areas of the Gdańsk Basin as well as determination of the meaning of "permanent" accumulation of that form of organic carbon in the sediments, in the last century. The part of this task is carried out under the project Eutrophication of shelf waters as a mechanism, which weaken the efficiency of the biological pump, which I am a contractor (attachment 4; II I-7).

I will continue the research related to a spatial and seasonal flow volume of the organic matter and its basic components in the marine environment. The part of this task I realize now within the framework of the COCOA project (attachment 4; II I-1). It has to indicate the function of the coastal zone of the Gulf of Puck as a filter involved in the transformation of carbon and biogenic compounds.

Based on researches conducted so far (the upward movement of water from greater depths around the Hel Headland, the high content of BC in sediments, the highest, among the studied, toxicity of the sediments and eluate) I hypothesized: that the sediments of the western part of the Gulf of Gdańsk can be upon certain conditions the secondary source of chemical substances, including persistent organic pollutants. Environmental data related to the benthic organisms in this region indicates their frequent deformities (oral information from PhD Katarzyna Smolarz). The reason for this has not been determined. Undertaking of this subject will lead to the comprehensive research of sediments and the water column, for which I going to secure financing.

Usage of results

The researches, I conducted may also have practical applications. The analysis of the concentration of suspended organic carbon (POC), and the ratio of POC/Chl *a* in different sea areas as well as the variability in time, are necessary: to model the processes of solar power supply, which occurs in the sea, to verify of existing models, which are used to prepare maps of environmental parameters based on satellite measurements (e.g. SatBałtyk).

The BC content in the marine environment affects the distribution, speciation and bioavailability of persistent organic pollutants. Therefore, the information about the content of carbon black (CB) in marine sediments may be a good indicator of the spread of pollution and exposure of living organisms on it. This knowledge can be the basis for an assessment of environmental risk: setting priorities, to which compounds and places should be undertaken urgent correcting operations and/or to make a decision to reduce the supply of chemicals, which deposition in marine sediments is not permanent.

5. The Discussion of other scientific and research achievements.

In 1988 – 1993 I was a student of full-time master's studies on the faculty of Oceanography on the Department of Biology, Geography and Oceanography of University of Gdańsk. I finished major of physical oceanography and got a master's degree on 29th of June of 1993. At that time, I got the first contact with scientific researches. Together with scientists of the Department of Oceanography and IFREMER, I participated in scientific experiment under the name of AMBER 1992. During the project *Chemical analyses of flux between water and suspend solids* I was responsible for the analysis of biogenic matter collected from the Puck Bay. This interdisciplinary project gathered scientists of water chemistry, biology and geology. It was also the first time I gained experience with estimation of biogenic matter in the water–sediments interface.

After I had obtained a master's diploma, I started to work on the position of marine measurement specialist in the Hydrographic Office of the Polish Republic in Gdynia (BHRP). I obtained licences to operate the first hydrographic multi-beam probe in Poland, to operate a side sonar and I got familiar with preparation of bathymetric map with Hydromap system. I had also a great occasion to acquaint with: the seabed terrain in the coastal zone (especially in Szczecin and Vistula lagoon), areas being under the anthropopressure (e.g. moorings, sea harbours, ship

approaching tracks), methods of the modern marine surveys and the thermohaline structure of the researched areas.

Since September 1994 I took up the PhD studies on The Environmental Biology and Oceanography Doctor's Studies at the University of Gdańsk (working in BHRP since march 1995). I continued my master's researches at that time. However, my master's thesis based on the archived data (only in 1990 I participated in the scientific voyage, analyzing chemical and physical parameters of sea water), since 1994 I was involved in preparation of scientific programme. I organized scientific voyages, carried out researches and analyses as well.

Through the next years I researched short-term changeability of trophy of the open waters of the Gulf of Gdańsk, having regard to the long-term eutrophication of the Baltic Sea and possible climate changes. I analysed the concentration of biogenic substances, oxygen and biomass indicators (chlorophyll *a*, phaeophytin, ATP) in accordance with the hydrological parameters and the growing season. My researches concerned the whole column of water from the surface to the bottom (basing on standard depths). The data collected during several days long measuring campaigns conducted through next years, let me to observe periodicity of changes in physical and chemical parameters of pelagic zone, as well as the long-term changeability. In my researches I concentrated on the vertical diffusive transport of biogenic substances in spring, considering streams at the border of the density layers of halocline and thermocline.

The results obtained at various stages of my scientific work I published, as well as I presented at numerous conferences and seminars. The first of my articles concerned the changes of concentration of dissolved silicates in waters of Gdańsk Deep in 1988 – 1995 (attachment 4; II A-17). In the surface waters, the concentration of silicon was observed at the level of less than 1 $\mu mol\ dm^{-3}$ with parallel decrease of concentration of that element in relation to nitrogen and phosphorus. In consequence silicon limited early-spring primary production in deep waters of Gdańsk Basin, causing replacement of diatoms bloom with others planktonic organisms, which do not require the silicon. The reason of these changes was mainly the process of the Baltic Sea eutrophication.

Among the conferences I took part, there were conferences on an international scale, like CBO (Sopot, 1994), BMSC (Ronne, 1996), BSSC (Rostock-Warnemunde, 1998), BMB and ECSA (Mariehamn, 1997) and on the national scale, as e.g. *Chemistry, geochemistry and marine environment protection* (Sopot, 1998), as well seminaries organized by Institute of Oceanography of University of Gdańsk. Among the topics were: *The impact of dynamic processes on the periodic changes of nutrients in Gdańsk Deep, Short-term changes in concentrations of nutrients and oxygen on the background of the density stratification of the water column of Gdańsk Deep, Daily relations between chlorophyll-a, nutrients and the solar radiation, Some periodic relations between dissolved and suspended materials in the microlayer and subsurface layer of the sea and the concentration of gas bubbles in the Baltic Sea, Daily UV absorption coefficient variation in sea surface microlayer in Gdansk Basin, Vertical distribution changes and the daily concentration of ATP in the open waters of the Gdańsk Deep.*

The researches I carried out were possible thanks to scientific projects I participated in (attachment 4; II I-14,15,16). The main objective of the project I led was to *Determine the daily changes of the biogenic substances concentration caused by a variable rate of photosynthesis in the euphotic layer*. The project based on the measurements and analyses made in June 1996 in the area of the Gdańsk Deep. The total organic matter was determined by identification of organic carbon concentration in the suspended matter, chlorophyll *a* (as an indicator of phytoplankton

biomass), pheophytins and adenozinotriphosphate (biomass of living microorganisms, i.a. phyto- and zooplankton, bacteria).

In 1995 I started work on the methods of determination of ATP in suspended matter, but the analysis of ATP in the previously collected samples was only possible when I got the external source of financing for my researches (attachment 4; II I-14). The daily changeability of biomass (including ATP) in euphotic layer in the context of changes of the biogenic matter concentration I presented in the doctoral thesis (Section 6.22, p. 132).

In July 2000, I took a PhD degree in Earth Sciences in the field of Oceanology for doctoral thesis entitled *Short-term changes of biogenic elements concentrations in the deepwater area of Gdansk Basin in the spring season.* The promoter of my thesis was dr hab. Lucyna Falkowska and the reviewers: prof. dr hab. Zbigniew Witek and prof. dr hab. Krzysztof Korzeniewski. At the request of the reviewers, the thesis was awarded by the Council of the Department of Biology, Geography and Oceanology. There are a few achievements of my doctoral thesis, which stands out from all the rest:

- the estimation of vertical diffusion streams of nutrients and oxygen from the deeper layers and an indication of the important role in complementing the resources of biogenic substances in the productive layer, which supports and even stimulates the process of photosynthesis;
- consideration of the proportion in which biogenic substances and oxygen was present in different layers and periods;
- determination that the succession of phytoplankton reflected a "succession" of nutrients, which leads to the replacement of limitation factor from nitrogen in early spring to phosphorus in late spring;
- an indication of 12-hour cycle of change in the daily changeability of concentrations of nutrient salts and the suspended matter, caused by increase of solar radiation at noon, and night heterotrophs activity;
- determination, that in early spring maximum concentrations of chlorophyll appeared early in the morning, while at the end of the spring season the first increase chlorophyll appeared before noon;
- determination of the periodicity of the tested parameters and conclusion that the frequency and magnitude of fluctuations in the concentrations of biogenic elements and organic suspended matter is conditioned by the wave motion duration and under the conditions of thermal stratification formed in the spring, determines the rhythm of changes of the entire isohaline layer.

In 2000, I was hired at the Department of Marine Chemistry and Environment Protection UG headed by prof. dr hab. Jerzey Bolałek. I broadened the researchers conducted by that time on the hydrochemical characteristics of the water column of open waters of the Gdańsk Basin, introducing: new research areas (e.g.: coastal zone, the polar regions), environment components (suspended matter, sediments, organisms) as well as the analysis of parameters (e.g.: forms of sulfur, black coal). Still, I continued work in the area of the Gdansk Deep in 2001 (beginning of June) and 2002 (beginning of May). I studied then the diurnal variation of the suspended chemical substances (C, N, P, BSi) and the volume of falling matter streams, reaching the different levels of the sea and the sediments. The obtained results allowed me to determine, among others: the vertical profile of carbon and organic nitrogen, total phosphorus and biogenic silica in suspended matter and the ratios C/N, C/P and C/BSi in which they are presented in the suspended matter; volume and quality of dropping matter; differences in volumes of C, N, P streams, between night

and day, indicating even twice bigger streams of matter in the night; quality of the falling matter, substantially more degraded overnight (attachment 4; I B-2; II D-9; III B-17,18,20,23). The vertical flows C, N, P and Si are among the first results for the Gdansk Basin.

The researchers conducted annually for 15 years in the spring and/or fall, in the region of the Gdańsk Deep of physical and chemical parameters in the water column as well as in bottom sediments reflected in scientific publications (attachment 4; II A-12,16; II K-19,20; III B 27-34).

An important for the reservoir trophy are sources of nutrients, the intensity of its delivery and the range of influence. My researches were conducted in three areas, where the surface waters are supplied with carbon and biogenic elements in the suspended and dissolved form. These were areas of: water propagation of the Vistula river; the area of the occurrence of Hel upwelling (not recognized yet) and the discharge area of treated wastewater into the Puck Bay from the treatment plant in Dębogórze. The Researches in this latter area had the character of before- and after-investment monitoring associated with the removal of the sewage collector into the Puck Bay. Works conducted in 2008-2011 in addition to information about the physical, chemical and biological parameters of water and sediments allowed to analyze long-term changes in this area (attachment 4; III M-3). Nearly 30 years earlier researches were carried out in the same area and in close range of analyzed parameters. These studies were presented in a monograph Puck Bay.

The physico-chemical characteristic of the region of the Gulf of Gdańsk, being under the influence of waters of the Vistula river, I performed during the research cruise on the ship Professor Albrecht Penck. These researches I conducted in February and March 2000 and 2001 in collaboration with Dr. Maren Voss from the Institute for the Baltic Sea Research in Warnemünde (IOW) and Dr. Marianna Pastuszak from MIR in Gdynia. During the cruise in the research area, apart from basic hydrological and optical parameters there were also analyzed: concentrations of nutrients and composition of the suspended matter. In samples collected from 25 stations I specified concentrations of suspended carbon, organic nitrogen and the biogenic silica. The concentration of biogenic silica (already determined) as well as data from the Gdańsk Deep, from the same year, including streams of falling BSi, are the first and / or the only information concerning this parameter in the Gulf of Gdansk (attachment 4; II D-9, III B-18).

In 2000-2003, I was carrying out a project led by dr hab. Maria Szymelfenig, which concerned: The role of upwelling in the development of biological productivity along the Polish Baltic Sea coast. It was an extremely demanding project from a logistical point of view. The most important stage, was to predict, basing on the weather forecast, hydrodynamic model and satellite images, the location of upwelling. Another problem was to reach the designated earlier area for the duration of this phenomenon. The implementation of the planned measurements and the sample collecting process for further analyzes completed the research cycle. In the three years we were able to identify only 7 such situations. The comprehensive work in the field of biology, chemistry and physics of the sea were carried out in collaboration with scientists from the National Marine Fisheries Research Institute. As a member of that interdisciplinary research team, I was responsible for the analysis of nutrients, oxygen and basic chemical composition of suspended matter. As the result of the conducted researches a significant number of speeches during seminars and conferences were prepared (attachment 4; II K-14,17), as well as my authorship or co-authorship in 4 articles (I B-3,4; II A-9,13). In 2006, together with colleagues who participated in the project, I received a 1st degree team award of the Rector (attachment 4; II J-2) for a series of articles being the result of the researches. Two articles concerning the composition of the marine suspended matter and changes in the distribution of nutrients and oxygen were incorporated into the scientific achievements.

The conclusions of these researches caused that in further scientific work I treated the area of occurrence of Hel upwelling as a special testing ground. In 2007, I conducted researches in this area in the framework of the BW project: *The vertical streams of organic matter and its basic components in the water column around the headland Hel* (II F-19).. The researches ran from March to November, in the two-months long cycle, at three research stations. Key findings include: it is an area in which there are strong changes in physical and chemical parameters (i.a.: salinity and temperature, oxygenation and pH, nutrients) that affect the composition and the bioavailability of matter (attachment 4; II E-4). On the one hand, often along the Hel peninsula the currents transfer relatively "clean" in the suspended matter and nutrients water from the north-east coast, on the other hand rich waters of the Vistula flow in the opposite direction.

Consequently, there are also trophic conditions conducive to high production of biomass in this region and hydrodynamic conditions to facilitate the loss of matter especially in the frontal area. There are also upwellings and downwellings present in this region. The first one is responsible for raising of nutrients and degraded suspension (can transmit the dissolved and adsorbed compounds to the surface and make it available). Whereas, the downwellings move well oxygenated water with a labile organic matter to deeper layers of water, probably helping aerobic mineralization of organic matter.

The work on the organic matter content and its primary composition within the sea water sediments began during my doctoral studies. In 1996, in cooperation with MIR, within the framework of a project: *The influence of Oder River on the ecosystem of Pomeranian Bay* (financed by Fundation of Polish – German Collaboration) I analysed contents of the organic carbon and nitrogen in the water sediments of the Pomeranian Bay. The analysed samples were collected in March and July 1996 as well as in May and October 1997. These researches together with the other analyses (content of total and organic phosphorus, losses during roasting, redox potential) let to discover, that the processes in the water column and the water flowing into the bay reflected the chemical composition of the bottom sediments of the Pomeranian Bay (zal.4; II A-15). The influence of the following processes was noticed in the bottom sediments: the early-spring domination of diatoms in the composition of phytoplankton, the intense allochtonic inflow of phosphorus rich matter flowing into bay with waters of Świna river, the volume of spring, summer and autumn bloom of phytoplankton, the consequences of summer flood in southern Poland in 1997.

Since 2000, I conducted the researches of the chemical composition of bottom sediments and suspended matter in the Gdańsk Basin. The work was realized in cooperation with National Marine Fisheries Research Institute under prof. dr hab. Zbigniew Witek management. The collection of samples was conducted during three, three days long voyages (September 2000, April 2001, June 2002) on r/v Baltica. In the area of the Gdańsk Basin I collected samples from almost 50 research stations. In the bottom sediments and suspended matter I analyzed: content of carbon, organic nitrogen and biogenic silica, whereas in the interstitial waters: biogenic substances, hydrogen sulphide, as well as redox conditions. One of the most important element of that project was an assessment of the stream of the falling organic matter (carbon, nitrogen and phosphorus) estimated on the basis of the sediment traps method.

As a result of these researches the sediments of the Gdansk Basin were classified due to the contents of carbon, nitrogen and silicon, chemical composition of the interstitial waters and the size and direction of flows at the water-sediment boundary. The total amount of C, N, P in different types of sediments was estimated, indicating a significant accumulation of these elements in the sediment between isobaths of 10-80m. Seasonal changes of the stream of carbon,

nitrogen and phosphorus was determined in the waters of the Gdansk Basin. It indicated that the mineral matter which reaches the bottom only at the mouth of the Vistula River and in the vicinity of the headland Hel dominated the organic matter. It was also found that the average flows of organic carbon and nitrogen in Gdansk Basin were almost twice lower than in the Gulf of Riga and more than four times lower than in the Gulf of Finland.

The results of the researches constitute a huge database. It was presented during numerous conferences (attachment 4; II K-16,18; III B-10,12,13,19,22), published in international science magazines (attachment 4; II A-10,11,) and included in monography entitled *The Geochemistry of the Baltic Sea surface sediments* (attachment 4; II D-4,5,6,7,9). The knowledge of sea sediment environment and the areas of intensive reaching of the organic matter became the basis of the next both national and international projects (e.g. HYPER, COCOA, MarineCO2).

An important from the point of view of matter circulation in the Gulf of Gdansk is its coastal zone. This is an area which is under the direct, often a strong anthropopressure. On the one hand, the negative impact is associated with the delivery of increased amounts of nitrogen and phosphorus affecting the circulation of organic matter in the environment. On the other hand, the proximity to seaports, industry or urban agglomeration causing the delivery of other contaminants, including hazardous substances. Another aspect concerning this zone is especially different types of civil works, which affects the seabed. Such an infringement of the seabed was the acquisition of sludge from the bottom of the Puck Bay to infill the beaches. As the result, an artificial narrow cavities were formed in a short distance to the shoreline, parallel along the Hel Peninsula. The researches in which I participated in 2002-2003 focused on the pit of "Kuźnica II" (attachment 4; II I-13).

The results related to the carbon and organic nitrogen content as well as pigments pointed to the high content of organic matter in the cavity. It was a trap for organic matter produced in the surrounding area. Mineralization of organic matter collected in the excavation was a source of phosphate and ammonia and stimulated primary production in this area (attachment 4; II A-14; III B-15,21,24).

The continuation of this research was the work carried out in collaboration with the Maritime Institute in Gdansk. The host project, directed by Mrs. PhD L. Kruk Dowgiałło was aimed at preparation of a natural basis and conditions for excavation reclamation program in the Puck Bay. The work on the bottom water chemistry and sediments were carried out across all excavations for four seasons in the deep area as well as at shallow and unchanged sediments. The organic matter was determined by the contents of carbon, organic nitrogen, pigments as well as utilizing the indicators of the quality (C / N, chlorophyll a / C, chlorophyll / chlorophyll, pheophytin +). The collected data confirmed earlier reports that cavities constitute a trap for the organic matter (attachment 4; II D-12,16,17; II K-12). It was found that, in excavation sediments from the Puck lagoon is up to twice more organic matter than in the excavation of the Puck Bay; the degradation of organic matter in the excavation leads to worsen the quality of bottom sediments (especially in July), the presence of hydrogen sulfide and reduction of the redox potential; the amount of matter in the excavation and its variation during the year depends on the hydrodynamic conditions, that are conducive to the accumulation in the excavations of Władysławowo and Chałupy as well as increase the removing of matter according to the rising distance from that area (excavation: Kuźnica II i I, Jastarnia).

Seasonal changes in the concentrations of nutrients and the content of carbon, nitrogen and phosphorus in suspended matter and shallow water sediments of the coastal zone I researched in collaboration with the Institute of Oceanology PAN, in the framework of the COSA project

(2003-2005) and in collaboration with Dr. Aleksandra Zgrundo (IO UG) in 2005 -2007. In both cases, the aim of the study was to determine the role of sandy sediments in the circulation of carbon, nitrogen and phosphorus. The work was carried out in the Gulf of Puck at the shallow station (0.5-1 m) in the neighbourhood of Hel and Gdynia, and samples of: water, the suspended matter and sediments, were collected at a frequency of 1 to 4 times a month. It was found, there are significant differences between the researched areas in the number of analyzed parameters and proportions in which they occur. Clearly higher concentrations of suspended matter was observed in the area of Gdynia and sediments reflected the course of changes of suspended matter in the water column (attachment 4; II D-5).

In 2003-2005, I participated in an international project COST-IMPACT related to *estimation of the cost of impact of bottom fishing on biodiversity and processes in marine ecosystems* (pkt). The project, led by Dr Melanie Austen (Plymouth Marine Laboratory), was carried out in three different marine tanks: the Mediterranean, the North Sea and the Baltic Sea. There are significant differences between tested water reservoirs: the trophy, the type of sediment, benthic fauna, trawl intensity, the type of fishing gear used. One of important elements of the project was the socio-economic aspect, among others, the attempt to estimate costs of the loss of biodiversity in the marine environment. The research work conducted in the Baltic Sea was realized by academics from the National Marine Fisheries Research Institute in Gdynia (the leader, Dr. A. Drgas) and ZChMiOŚM UG (leader prof. Dr. Hab. J. Bolałek). One of the necessary steps in the project was to prepare and carry out flow experiments, allowing to estimate flows of chemical substances at the water-sediment boundary. In that time, I used the experiences of colleagues from Greece (IMBC) and Norway (NIVA). Before the commencement of the researches and experiments in the Baltic Sea I participated in the two-week cycle of field and laboratory work at the Institute of Marine Biology of Crete (Institute of Marine Biology of Crete, Heraklion), where the part of the project, covering the eastern part of the Mediterranean was carried out (attachment 4; III L-2).

In the Baltic Sea as well as in other maritime areas: estimated streams of nutrient salts and oxygen from trawled and non-trawled areas; determined carbon, nitrogen and chlorophyll in samples of sediments and suspended matter, determined the concentrations of nutrients and oxygen in pore and bottom waters; the researchers conducted twice during the growing season (beginning of the growing season and its center, March and July 2003); samples were taken from four positions (each consisting of a trawled and non-trawled area), located in areas of the Gulf of Gdańsk with different intensity of catches.

In the trawled areas, it was found: resuspension of highly hydrated surface layer of the sediment and the resedimentation; increased release of ammonia, phosphates and silicates of the sediment (sludge) as a result of the mechanical action during the trawling; the intensification of the nitrification after trawling, resulting from oxygenation of the sediment and the release of nitrates and nitrites into the bottom water; in sediments, higher carbon content and an increased share of coal of phytoplankton origin, which might have resulted from an increase in primary production in the water column above the tested area; the sediment differences noticed in vertical profiles of organic carbon and nitrogen concerned only 2 cm of the surface layer, indicating the absence of mixing caused by trawling. The differences in the streams of nutrients between trawled and non-trawled areas were found in the Greek area. In the case of benthic organisms, only in the Baltic Sea sediments there was no bottom fishing impact on their composition and quantity (attachment 4; II E-6,7; II K-15; III B-14,42,43).

The content of the organic carbon in different components of marine environment, especially in marine sediments is frequently considered as an indicator of total contamination with organic matter. In the Baltic Sea sediments the organic carbon can also come from the land and constitute from 10 to 30% of the total organic carbon. However these researches concerns only the natural matter, animal and plant remains, soil humus. The other sub-fraction of the organic carbon present in sediments is soot. This is mostly amorphous carbon, with a source in processes of incomplete combustion of the biomass and fossil fuels. The soot doesn't transform in environment and can be treated as an indicator of direct anthropogenic polluting of the atmosphere or sediments. Within the meaning of the atmosphere, soot is mostly called an "elementary carbon" (EC), however within the meaning of sediments, a name "black carbon" (BC) is most often used. Due to the small size of soot particles, a different shape and porosity it is also believed, that this form of carbon, has a sorption ability of dissolved organic substances.

I carried the researches related to the content of carbon and its forms in the atmosphere within the project BW, entitled *The organic and elementary carbon in aerosols of the coastal zone of Gulf of Gdańsk* (based on example of Gdynia) in cooperation with PhD A. Lewandowska (attachment 4; II I-20). The samples of aerosol were collected on the station localized at the roof of the IO UG in 2003 – 2005. The main goal was to determine the seasonal changes of suspended matter (PM_{10}) and carbon aerosols (TC, OC, EC, IC) in coastal zone of an urban area. It was the first research of that kind, realized in the coastal zone of the Gulf of Gdańsk. Based on the obtained results it was determined: the relative proportions between the carbon constituents, molar ratio of carbon to nitrogen in organic aerosols, concentration of secondary organic carbon. The coal matter constituted approximately 25% of suspended aerosols and its participation in the suspended matter (PM_{10}) during the cold period was only 7% higher in comparison to the warm period. The concentration of total nitrogen was five times higher in the cool period than during the warm period, however more intensive removing this element from aerosols increased the molar relationship TC / TN. Average values of OC / EC corresponded to the values observed in urban areas. In the cold period ratios of this proportion was observed at the level lower than 1. It indicates a significant share of anthropogenic aerosols derived from the combustion of fuels in cars, especially diesel cars.

The maximum value of this ratio of up to 16 (observed in summer) indicated the presence of secondary organic aerosols in the area of Gdynia. The results were presented, during conference (attachment 4; II E-5, III B-11), and next results covering the period 2007-2008 was also published (attachment 4; II A-6). As part of this collaboration I was able to compare the methods of the carbon determination using the CHN analyzer. Samples were analyzed in the laboratory the Ispra Joint Research Centre in Italy.

To the marine sediments the soot comes from the atmosphere, but mainly with the outflow of the rivers. Pyrogenic particles are considered to be much more efficient sorbent of many organic substances, including PCBs and PAHs, than the rest of the organic matter present in the sediments. In the coastal sediments of other water reservoirs the presence of soot was observed in a wide range of values, from several to several dozen %. Researches on BC in the sediments of the Gulf of Gdansk ran in collaboration with Dr. Marta Staniszewska IO UG and Dr. Grazyna Sapota from the Maritime Institute in Gdansk. The results of these researches were, among others: separation of areas with a higher share of BC in the total carbon content and determination of a positive relation between tested persistent organic pollutants (POPs), and the contents of the BC in marine sediments. Results of researches conducted in April 2007 was published and form the basis of the scientific achievement (point Ib).

The subsequent work on the BC content in marine sediments were carried out in 2011-2012 and were associated with my participation in a project led by Dr. Marta Staniszewska. That time, the reasearches included the shallow waters of the coastal zone (20-40m), were considering seasonal variations and another group of organic substances - alkylphenols. In this project I was responsible for conducting environmental studies, determination of basic physical and chemical parameters of sediments, including the determination of the carbon form and the discussion of alkylphenols content in the sediments in the context of the quality of matter (C / N) including the share of BC. The obtained results were presented on conferences and seminars, as well as published (attachment 4; II-2; K-3; III B-1,2). A recent publication concerning this subject, has been accepted for publication in 2015 and is on the editorial revision (attachment 4; II A-1).

In addition to works related to the contents of the BC and particular organic substances in marine sediments, I conducted also researches on the toxicity of marine sediments. This researches were carried out within the project NCN, managed by dr. Elizabeth Niemirycz. The results of measurements of toxicity of sediments are an important indicator of the description of the aquatic habitats status. Most chemical compounds have different routes of exposure and toxicity of many is unknown. Moreover, the toxicity of many of them is a result of synergetic and antagonistic interactions of the different components present in sediments and bioavailability of these compounds can vary with environmental conditions. In this case, analysis of the individual substances may not reflect the environmental risk caused by sediments. Given, that there is a relationship between the content of BC in sediments and persistent organic pollutants, researches were undertaken to determine the impact of BC content on the toxicity of sediment. Researchers conducted in September 2007 in the Gulf of Gdańsk, showed that the majority of the analyzed sediments are toxic and that there is a strong positive correlation between the toxicity of sediment and the content of BC. The result has been published, and the work has been incorporated into the scientific achievements (attachment 4; II B-6).

A particular area, among others, due to the sensitivity to climate changes, which related to my research, is the Arctic. In waters of the eastern part of the Greenland Sea, I analyzed the horizontal and vertical distribution of nutrients concentrations (attachment 4; III B-36). This task was carried out in collaboration with Dr. Ilona Goszczko of the Institute of Oceanology of PAN in Sopot. I tested bottom sediments and demersal waters from fjords, lakes and tidal planes of the northern part of Spitsbergen. The content of the organic matter in sediments and nutrient salt concentrations in demersal waters were a reference to the discussion about the PCBs and PAHs content in sediments and about sediments as a natural environment of aerobic bacteria (attachment 4; II A-5,8; II K-4). The inspirer of that researches was Dr. Barbara Wojtasik from the Institute of Biology of UG.

The subsequent researches was also focused on the polar environment. At the turn of 2009/2010 I took part in a scientific expedition on the scientific-research vessel "Akademik Ioffe" in cooperation with the P.P. Szyrszow Institute of Oceanology of The Russian Academy of Sciences. The research area included the water mixing zones of the Atlantic Ocean with: the Indian Ocean (Pool Agulhas) and the Pacific (Drake Passage). They also represent a potential route of transportation of the organic matter and contaminants adsorbed on its surface from shelf waters of South America and Africa in the direction of pelagic zone of the Southern Ocean. During the cruise, a number of researches related to chemistry, biology and toxicology were conducted. In addition to researchers from Russia and France, a group consisted of nine scientists

and PhD students of the Institute of Oceanography participated in the voyage. The leader of the team was prof. dr hab. Maciej Wołowicz. During the cruise an extensive research material was collected (samples from over 80 stations), which further analysis was possible thanks to the gained NCN scientific project (attachment 4; II I-10). One of the important objectives realized on the basis of the collected material was to evaluate the frontal zones influence on the quantitative and qualitative diversity of suspended matter. The task let to determine the distributions of particle size, the concentration of the suspended matter, its basic chemical composition (C, N, P, BSi,) and a content of the selected pollutants (PCBs, PAHs, Hg, Cd, Pb). The most important conclusions of researches were: a relation between the localization of fronts with occurrence of zones of increased concentration of the suspended matter, existence of differences in the chemical composition of suspended matter in separated masses of water; content of mercury and POPs in suspended matter indicates their source and method of spreading (attachment 4; II E-1,2,3).

In recent years, due to the observed climate changes, it is hypothesized about the possibility of changes occurring in the polar regions. This raises the question whether and how it will affect biogeochemical cycles of elements such as C, N, P or Si? Whether and to what extent the pollution produced by man reaches, the remote polar regions? What is the role of organic matter in this transport?

The asked questions as well as preliminary results of the Southern Ocean research were the basis for the creation of a monitoring program entitled; Geochemical monitoring of the Antarctic environment and the volatility of functioning within biotic components of the environment of Admiralty Bay on the Polish Antarctic Station. H. Arctowskiego (attachment 4; II K-2, III A-1). The works are utilized in cooperation with the Institute of Biochemistry and Biophysics of the Polish Academy of Sciences. The implementation of this project involves employees of the Institute of Oceanography: Dr. Anna Chodnicka-Panasiuk- initiator of the collaboration, Dr. Ewa Szymczak, Dr. Dorota Pryputniewicz-Flis and Dr. Katarzyna Łukawska-Matuszewska. The planned research repeated the research on trophic conditions of the marine environment, which were carried out in this area in the 70s of the last century, and expands with new analyses, among others the amount and quality of the organic matter in the water column and sediments as well as persistent organic pollutions. In May of this year, the first samples taken from Admiralty Bay during the XXXIX Polish Antarctic Expedition reached IO UG. One of the tasks of monitoring is to compare contemporary and archival data and evaluation of multi-annual changes in this environment.

Since 2014 I am also involved in two international projects: COCOA coordinated from the Polish by dr. hab. prof. Urszula Janas of the University of Gdańsk (attachment 4; II I-1;) and MarineCO2 led by dr hab. prof. UG Adam Sokołowski (attachment 4; II I-2;). The first concerns defining the role of the coastal zone in circulation of nutrient salts. This is a continuation of work carried out in the HYPER project, in which I examined the streams of nutrients in the areas of hypoxia or anoxia (attachment 4; II I-3; I B-5; II K-3,5; III B-6,7,8,37-41). This project is carried out by scientists from all Baltic countries (including Denmark, Germany, Finland, Sweden, Lithuania, Russia) and is oriented to determine the influence of different types of coastal ecosystems on circulation of the carbon and biogenic substances. One of the tasks of this project is to present the results to the public and to indicate the role of these most vulnerable to human activity water areas for the Baltic Sea, especially in the context of projected climate change.

The second project is a continuation of previous cooperation within the framework of the EU project ECO2 (attachment 4; III B-35). The main purpose of me and a group of co-workers is

to assess the impact of acidification of sea water on the chemical composition of sediments, and thus on the living conditions of marine organisms, especially of benthic organisms. For this purpose, an experiment will be carried out under controlled conditions: natural and altered, with the inclusion of different groups of benthic organisms. The temperature and pressure will be controlled. Experiments will be carried out in the SINTEF / NTNU laboratory in Trondhaim.

For many years, I am cooperating with employees of Oceanology of PAN in Sopot, as regards the assessment of the quantity and quality of organic suspended matter in surface waters of the southern Baltic. The work was started in 2004 by Dr. Slawomir Kaczmarek. It was resumed in 2007 by dr. Slawomir Wozniak and now is being continued in the project SATBałtyk and led by Dr. Joanna Stoń. The data obtained in this period were presented in the form of reports () as well as presented at conferences and working meetings (attachment 4; II K-1, III M-1). Year 2015 is the last year of the project and apart from using the collected data to validate the model it is also planned to prepare an extensive article describing the variability of these parameters.

Summary

In my scientific work I pay special attention to interdisciplinary of researches. The result of that fact is involvement in many research projects and collaboration with scientists, who represent different fields of knowledge and researchers units. The common denominator of my scientific interests and scientific activity is variable in time and space characteristics of carbon and biogenic elements in the suspended and dissolved form as well as the processes associated with the transformation of matter in the water column and in the sediments. Matter is characterized by the content of carbon, nitrogen, phosphorus or silicon. The transformation of matter that occurs in changeable environmental conditions allows to determine the direction of the flow of biogenic salts are products of processes of mineralization and / or dissolving suspended constituents or present in sediments matter. Important in this context is to consider the natural intensities of these processes in areas of varying strength of hydrodynamic processes or anthropogenic impact.

In total, my accomplishment includes 24 original works (21 post-doctoral) published in English in journals currently indexed by a list of Journal Citation Reports (JCR). The total *impact factor* (IF) is 20,54. The total number of MNiSW points is 495 (for 2014). The information contained in the publications were 122 times quoted and according to the Web of Science database the value of "H" index is 7.

I am the author or co-author of 17 chapters in peer-reviewed monographs (including 7 in both Polish and English). The results I presented at numerous conferences and symposiums, being authored or co-authored 63 papers and posters (52 post-doctoral). I was awarded the team prize of the Rector of UG for a series of publications *The role of upwellings in the development of biological productivity along the Polish coast of the Baltic Sea* and the prize for the best article on the marine environmental protection published in 2011, in the pages of the quarterly "Oceanological and Hydrobiological Studies" . I reviewed 3 scientific articles in journals. I am an auxiliary promoter of two doctoral dissertations.

In the course of my research, I was a manager in a 6, the 14 research projects, including 4 international. Currently he performs 3 research projects, including 2 of the EU.

The wide range of my research work was possible thanks to collaboration with researchers from different institutions: the Polish Academy of Sciences, the National Marine Fisheries

Research Institute, PGI, The Maritime Institute in Gdansk, The Institute of Hydroengineering and The Institute of Biochemistry and Biophysics of the Polish Academy of Sciences in Warsaw. At that time, I worked with: prof. dr hab. Zygmuntem Kluskiem, prof. dr hab. Zbigniewem Witkiem, dr hab. Barbarą Urban-Malinga, dr Janem Warzochą, dr Barbara Paplińska, dr Jackiem Nowackim, dr Lidią Kruk-Dowgiałło, dr hab. Elżbietą Łysiak - Pastuszak. I cooperated also with scientists from other countries: Maren Voss, Melanie Austin, Morten Schaanning, Cris Smith, Jacob Carstensen, Murat Van Ardelan.

The cooperation with the scientific staff of other disciplines also led to the creation of interdisciplinary work involving the processes occurring in the marine environment (attachment 4; II A-3,5,7, K-1,2,11,13; III B-3,9).

Didactic, popularizing and organizational achievements

My activity for University of Gdańsk began during my doctorate studies, when I represented the voice of PhD students in the election of the rector of the University of Gdańsk (1996) and I was liable for study schedules of Faculty of Oceanography (1996 – 1999). Since 2000, as an employee of the University of Gdańsk, I took part in work of different institute and faculty commissions (attachment 4; III C). I was a member of the Faculty Committee, as an adjuncts representative (2008 – 2012), a chair of the Selection Committee for Biology, Geographic, Oceanography and Environment Protection Faculty (2005 / 2006), a chair and a member of diploma examination board (2011 - 2014). Currently I am a member of the Institute of Oceanography Committee for National Qualifications Framework of the field of study of Geology (since 2012) and Marine Ichthyology (since 2014).

In the years 1994 – 2014, within my teaching duties, I taught over a dozen of courses (largely author's), primarily for the field of study of Oceanography and Geology Geologia (attachment 4; III I). At the beginning, I started to teach courses dedicated to implementation of computers in Oceanography, where the students got familiar with text editors, spreadsheets and specialized software as *Surfer* or *Statistica*. Since 1994 in prof. dr hab. Lucyna Falkowska care (PhD in that time) I conducted specialized practice courses in the sea and the coastal zone, as well as, since 1996 courses in the field of Chemical Oceanography. The knowledge and skills I acquired during that time, became the base to self-reliant work and led them for ten years. In that time, I worked out an uniform guidelines for the courses I realized, I took care of proper preparation of chemistry laboratory and equipment base development, I led and helped PhD students to start teaching. In 2014 I had a chance to present experiences acquired in that field during Good Academic Conventions in Nature Sciences Seminar – Assessment in academic didactic (attachment 4; III J).

Very important author's course prepared and taught by me since 1995 is called Elementary Analysis of suspended matter and bottom sediments. It started when I was entrusted with CHNS/O elementary analyzer Perkin Elmer 2400. At the beginning, I received significant support from Mrs MSc Ewa Grodzisz (Faculty of Analytical Chemistry, Technical University of Warsaw), as also Mrs MSc Małgorzata Przytarska (Faculty of Chemistry, University of Gdańsk). Today, courses concerning methods of determination of elementary chemical analysis (C, H, N, S) of individual components of environment (bottom sediments, soil, suspended matter, organisms) and ecological stoichiometry are realized as lecture and practical courses.

During my professional work, I took care of many theses (attachment 4; III J). I helped and supported students to graduate (Master and Bachelor level) through planning field and laboratory work, preparing workplaces and assuring financial resources to accomplish necessary work. In 2000 – 2014 I promoted 26 masters in the field of Oceanography and Environmental Protection, as well as 16 bachelors in the field of Environmental Protection.

In 2008 I was proposed to write *Laboratory Manual* for the subject entitled *Chemical Oceanography* within the 1st stage of building and creation of Namibe Fishery Academy, realized by Gdynia Maritime University. Next task I was asked for, was to write a course book for the subject mentioned above (2nd stage). The book was published in 2014 in portuguese language ((attachment 4; II D-1) and is intended for students and teachers of the new university in Angola.

In 2005 – 2010 I was responsible for coordination and co-organization of many events realized by Department of Marine Chemistry And Environmental Protection. I attended in Baltic Festival of Science, co-organized 15 other science events, in 8 cases I managed to gain founds from WFOŚ in Gdańsk. All that objectives addressed to all inhabitants of Gdynia was accomplished successfully thanks to cooperation with students and other employees of department.

In 2009 – 2014 I was appointed as a head of a project under the University of Gdańsk patronage of ecological activities of school in Goręczyn. In that time many of pupils, teachers, as well representatives of local government, Local Fishery Group and employees of Kashubian Landscape Park mostly from Kościerzyna and Kartuzy poviat had a great occasion to participate in science courses, classes, as well field- and laboratory exercises prepared by employees and PhD students of Department of Marine Chemistry And Environmental Protection and Department of Biology of our University. All activities was made within Youth Ecological poviat assembly, ecological project "Ostrzyce lake, on the way to the Baltic Sea" (co-financed by WFOŚ in Gdańsk), during many visits of Goręczyn's pupils in University of Gdańsk and summarizing conference organized at the end of the project.

I participated also in educational Project „Development through competences" managed by University of Białystok (2009 – 2012). I prepared and gave over 30 four hour long lectures about chemistry of environment, especially of water environment, like: Chemical weapons in Baltic Sea, Household as a source of chemical pollutions, Water resources in Poland and over the world, Optical methods in analytical chemistry. During my lecture I met pupils from over 20 schools, propagating the knowledge concerning the circulation of chemical substances in environment, consequences of polluting the natural environment and methods used during researches.

Besides didactic and popularizing activities, very important part of my work constituted the scientific voyages. That voyages was realized in cooperation with the Polish Navy (scientific – didactic voyages) and National Marine Fisheries Research Institute in Gdynia (attachment 4; III Q). Since 1994 till 2002 I participated in preparations and realization of 9 voyages for students of our university. Next, since 2003 I was a leader of these voyages (19 voyages). In 2000 – 2002 I was responsible for organization and realization of chemical sediments and suspended matter researches during 3 three week long voyages on H/V Baltica. The researches in cooperation of Department of Marine Chemistry And Environmental Protection of University of Gdańsk and Department of oceanography MIR-IB was carried out under prof. dr hab. Zbigniew Witek management. I participated also in voyage preparation to The Antarctic.

My experiences acquired during voyages and courses, were used for expansion of Institute of Oceanography. In 2004 – 2006 I was a member of inter-department team responsible for

expansion and equipping of the new building of Institute. Since 2012 I am a member of inter-department team for building of a new training-research ship. In both cases my work was concentrated on participating in organizational meetings, preparation of proper documentation and instructions for designers, as well as participating in tenders for specialized equipment of the new Institute building and the ship (attachment 4; III Q). In 2013 NAVIMOR INTERNATIONAL Ltd. and the Gdynia Maritime University invited me to become an expert in project of building of a new Chemical Oceanography Laboratory in being built Namibe Fishery Academy.

During my work for University of Gdańsk I prepared many seminars, syposia and conferences. I also was a member of the organizational committee of: 6th National Methodological Conference *Protection of environment within studies of natural sciences* (1998), symposium *Gdańsk Deep in oceanographical researches realized in cooperation with Polish Navy in Gdynia* (1997), as well a secretary of international symposium *Functioning of coastal ecosystems in various geographical regions* (2001) and twice (2001, 2007) co-organizer of oceanographer conventions. In 2004, together with co-workers from National Marine Fisheries Research Institute (MIR), I organized International Fisheries workshop within the COST-IMPACT project. Besides the main organizers of the project, like MIR, University of Gdańsk or PLYMUTH, workshop attracted persons and institutions potentially interested in usage of the project results from Lithuania, Latvia and Estonia. In 2013 I personally organized a science seminar *From knowledge to practice* dedicated to 25th anniversary of cooperation between Institute of Oceanography and Polish Navy.

Another significant experience I acquired was gaining and realization of the European science project named COST-IMPACT (5th UE). The part realized by our University was led by prof. dr hab. Jerzy Bolałek. Within the project I was responsible for: contact with the leader of the whole project dr Melanie Austen (UK) and other partners, like NIVA, MIR-IB, coordination with polish partner, financial settlement preparation (partial and final), as well archiving project documentation. It was a very important period in my professional work, when I had an intensive training in realization of European projects like that in Poland (attachment 4; III Q).

Dorota Burska