REFERENCES

1. Jeppesen E. Subfossils of cladocerans in the surface sediment of 135 lakes as proxies for community structure of zooplankton, fish abundance and lake temperature / E. Jeppesen, J.P. Jensen, T.L. Lauridsen, S.L. Amsinck, K. Christoffersen, M. Søndergaard, S.F. Michell // Hydrobiologia, Netherlands. – 2003. – Vol. 491. – P. 321–330.

2. Frolova L.A. Subfossil Cladocera (Branchiopoda, Crustacea) in climatic and palaeoenvironmental investigations in Eastern Siberia / L.A. Frolova // International Multidisciplinary Scientific GeoConference, SGEM 2016, Russia. – 2016 – Book 4 Energy and Clean Technologies, Conference Proceedings. – Vol. II. – P. 601–607.

3. Szeroczyńska K. Atlas of Subfossil Cladocera from Central and Northern Europe / K. Szeroczyńska, K. Sarmaja-Korjonen // Friends of the Lower Vistula Society. – 2007. – P. 84.

RECONSTRUCTION OF THE POST-GLACIAL ENVIRONMENTAL VARIATIONS BASED ON THE MULTI-PROXY APPROACH: DŪKŠTELIS LAKE, EASTERN LITHUANIA

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Though numerous lithological, palaeobotanical and chronological investigations were carried out across the territory of Lithuania revealing environmental variations during the Lateglacial and Holocene, not so much is known about the changes of the sedimentological regime of the basins that has been directly determinate by the climatic fluctuations, surface dynamic, anthropogenic impact and etc. Deglaciated during the earliest stages of the Lateglacial, the Eastern part of the Lithuania serves as a promising area for the evaluation of the above mentioned fluctuations.

Here we briefly present results of the detailed interdisciplinary approach, involving geological techniques, applied to investigate post-glacial sedimentological changes of the Dūkštelis basin situated in the Eastern Lithuania (54° 50’ 10”N, 25° 9’ 59”E). The investigated site is located in the marginal area of the Last Glacial Maximum, surrounded by the formations of the South Lithuanian Phase, within the hummocky moraine zone. From the North boggy area borders with end moraine and glaciolimnic sediments are located southwards. In order to reconstruct the post-glacial geological-geomorphological development of the surroundings of Dūkštelis site, a set of black-white stereoscopic aerial photos (scale 1:17 000; 1952) has been interpreted. Alongside with this, the area was also digitalized applying the digital reconstruction model LIDAR (Guobytė and Rimkute, 2013). Obtained data suggested that Dūkštelis Lake was one of a few in the lake system that existed in area during the Lateglacial. Since the onset of the Holocene the size of the water bodies decreased by around 85%.

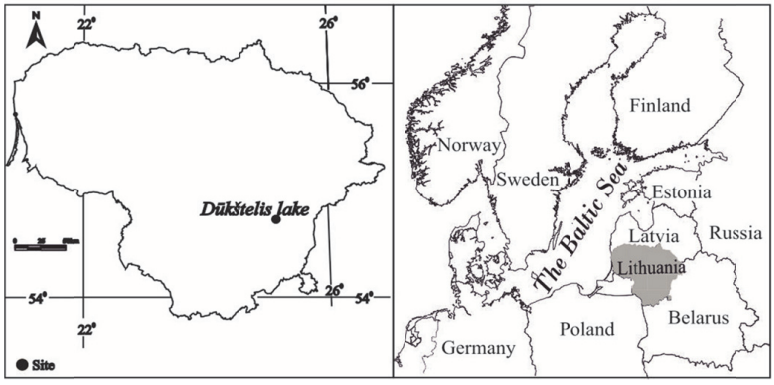

Fig. 1. Location of the study area

Post-glacial history of the local catchment and surrounding morphology have been analyzed taking in to account the results of the multiproxy studies of the Dūkštelis Lake sediment sequences. All together 7 cores have been taken and analyzed, records synchronized through lithological boundaries as well as magnetic susceptibility data. According to that, cross sections of the paleolake were modeled. The complex investigations of the deepest sediment core (1300 cm) consisted of palaeobotanical (spore-pollen analysis), lithological (grain-size and loss-on-ignition survey (LOI)), measurements of magnetic susceptibility (MSus), isotopic (^{14}C, AMS, δ^{18}O and δ^{13}C) studies and geochemical analysis. In total, 127 pollen samples, 110 samples for grain-size, 636 samples for MSus, 44 samples for isotopes, 133 for LOI and 86 - for geochemical elements were investigated. More than 500 terrestrial pollen grains were counted per sample and taxa are presented as percentages of sums of arboreal and non-arboreal pollen grains. Age/depth model was constructed according to the age/depth plot median values; sediment accumulation rate was calculated for each centimeter of the core. Besides pollen and spores, green algae such as Pediastrum (e.g. P. simplex, P. duplex) and testate *amoebae* (*Amphitrema flavum*) taxa, were calculated. Alongside notes were taken for bigger mineral pyrite crystals.

Based on characteristic taxa and results of cluster analysis investigated sediment sequences were sub-divided into seven sedimentological stages (Fig. 2.).

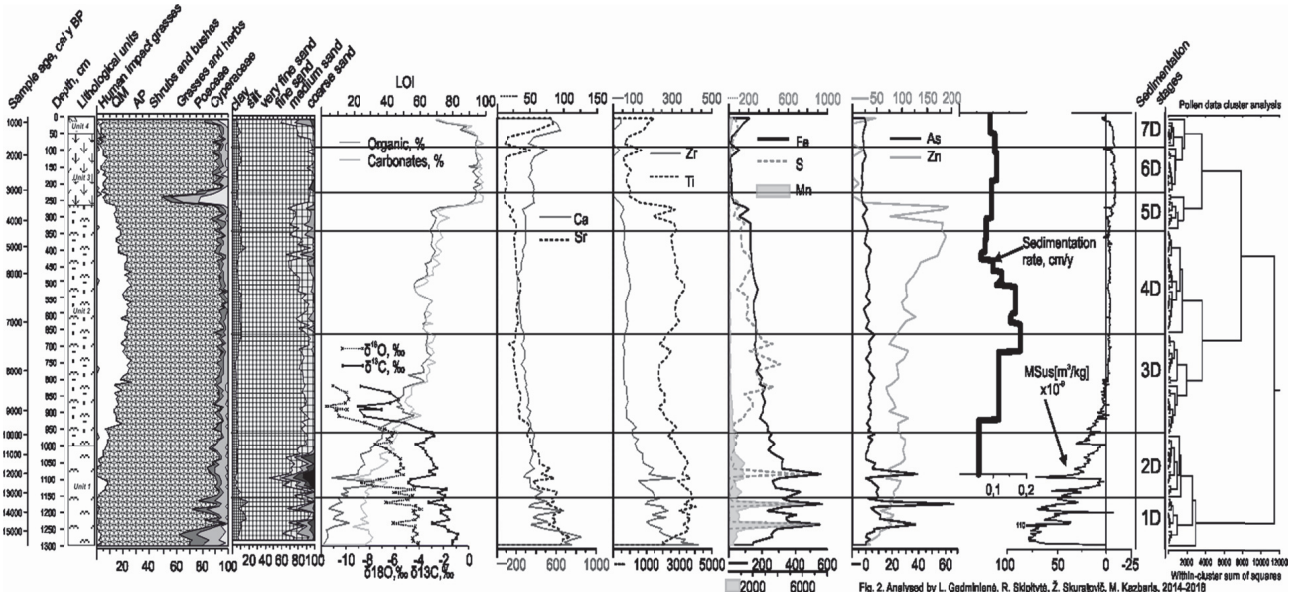

Fig. 2. Summarizing diagram of multi-proxy approach of the deepest sediment core taken from Dūkšteliai Lake

Stage 1D (before 13,200 cal BP). During stage 1D Dūkšteliai Lake was an open water basin. The lowermost lithological unit (Unit 1) contains richly calcareous gyttja, laminated, light bluish-greyish, sandy-silty, with clay lenses and with very low input of organic matter. MSus values are high within this interval. The geochemical investigations proves high instability of this record with high peaks of S, Fe, Mn, As. Enrichment of the sediments by Ti and Zr as well as high concentration of Ca and Sr proves terrigenous origin of investigated strata. *Juniperus – Betula –* Cyperaceae - *Hippophae rhamnoides* found in the bottom part of the sediments (LPAZ 1P) responses to Early Bølling pollen zone, the first thermal episode in Lateglacial (Fig. 2.). At the time, the natural environmental conditions were unstable, poor vegetation predominated and the soil was in the process of formation in most places. Simultaneously, the environment (in surface sediments) was filled with fine terrigenous substance which could easily get to the bottom of the lake sediments due to intensive erosion.

Stage 2D (13,200 – 9,900 cal BP). Multi-proxy records reflect high palaeoenvironmental instability in stage 2D. Firstly, in the beginning of this sedimentation interval broadleaved trees pollen appears in the pollen spectrum (approximately at about 13,000 cal BP). At the same time remarkable peak of organic matter and drop of MSus curve is visible, as well as extremely low isotopic δ^{18}O and δ^{13}C val-

ues, significantly lower Fe, S, Mn, Zr, Sr is determined. All data point to a climatic amelioration, with higher bioproductivity, which initiated migration of the elements to which the organisms are capable of adapting themselves, simultaneously providing a removal of the excess elements. A warm period with a decreased of some elements sedimentation was comparably short. According to the modeled data, if the sedimentation at that time could have been about 0,06 cm/year, 0,5 m warm interval representing sedimentation interval could have lasted about 800 years and which probably was interrupted with some cold event, that could have lasted no longer than 300 years. This is suggested by appearance of dryer and colder climate tolerant vegetation pollen such as Ericaceae, *Artemisia*, *Juniperus* in the pollen diagram. Simultaneously, a remarkable input of coarse grained sand is seen, which nicely correlates with higher concentrations of Zr and Ti, Sr and the increase of MSus. At the upper part of 1D sedimentation stage obtained data suggest the instability of the environment gradually decrease as i.e. predominance of thin layer of soil on the lake shore, remarkable fluctuations of the water table, changes in redox conditions and etc. calms down.

Stage 3D and 4D (9,900 – 7,300 cal BP and 7,300 – 4,500 cal BP). Multi-proxy data in lithological Unit 2 suggest an amelioration of the general climatic situation. Broadleaved tree pollen dominates in the spectrum. Accumulation rate fluctuate from 0,1 to 0,2 cm/year. The highest accumulation rate is determined in the Middle Holocene, at about 6,500-7,500 cal BP at possible Holocene thermal maximum. Described bed is covered by gyttja, consisting of 40 - 70% of organic matter. Here, sediments have a decreasing trend of MSus, with increased sulfur curve in the *Stage 3D* and high concentration of Zn approaching the upper limit, *Stage 4D*, of the interval. Recorded composition of the sediment bed points to the predominance of high water level and intensive mineralization, but also fast deposition processes and very high bioproduction. A lake contains excess dissolved nutrients, it becomes eutrophic. Green algae increased curve indicate lake trophic stage maximum and hydrological condition change accordingly. Highest pyrite accumulation correlates with green algae maximum and probably could be caused by the lack of oxygen in the deeper water bed.

The highest representation of the organic matter was recorded in the third lithological unit, which consists of more or less decomposed peat. Describing the environmental dynamics, 3 sedimentation stages (5D-7D) have been identified within this unit.

Stage 5D (4,500 – 3,100 cal BP). This stage is represented with very high pollen and spore concentration, increasing curve of organic matter, Ca, Zn element concentration, the flourishing of the aquatic (*Typha, Menyanthes, Nymphaea*) taxa, grasses and herbs. Simultaneously, the gradual decrease is noted in Sr, Ti, Zr, Fe, S and MSus representation. In the beginning of this stage very fine and fine grained sand has higher values. Recorded changes both in geochemical and biological proxies could point to constant reproduction and decomposition of the large amount of biomass in a eutrophic system.

Stage 6D (3,100 – 1,800 cal BP). Abrupt appearance and flourishing of Sphagnum, maxima exhibited by Ericaceae. At this sedimentation stage closed basin and shallow shores, nutrient-enriched water initiated bogging processes that started in the basin.

Stage 7D (after 1,800 cal BP). The top of the sediments consists of disintegrated peat with very fine to coarse sand and an increased MSus values. Sediment slightly enriched with heavy metals, more carbonaceous. High flammability at the latest stage of the sediment formation is observed.

Conclusions: A detail radiocarbon dating of the section revealed that the area deglaciated much earlier than it was thought before. At the beginning of the Early Holocene the climate stabilized coursing formation of the rich soil layer. Formation of the entire plant cover prevented erosional processes. Alongside with the closing of the basin more and more nutrition concentrated in the lake which led to its eutrophication while the decrease of oxygen content slowed down the mineralization of organic substance. At the end of the Middle Holocene the investigated part of the lake bogged up.

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REFERENCES

1. Guobytė R. Aerofotonuotraukų stereoskopinės analizės panaudojimas archeologiniuose tyrimuose. Metodai Lietuvos archeologijoje. Mokslas ir technologijos Lietuvos praeities pažinimui. – 2013. – P. 606–617.

PALAEOGEOGRAPHY OF THE LOWER KUYA VALLEY (EUROPEAN ARCTIC RUSSIA) OF THE LATE HOLOCENE

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Previous study of the Quaternary palaegeography of the Kuya River valley (Lavrov, Potapenko, 2012; Andreicheva, 2002; Isakov et al., 2017) does not concern the Holocene environmental history. Our preliminary conclusions from investigation of lithological composition and palynological study of Holocene alluvium have been presented earlier (Marchenko-Vagapova, Buravskaya, 2017). The results are supported by new palynological data.

The alluvial sediments in the Lower Kuya valley in the European part of the Russian Arctic were studied in section K12 (67°37′N, 53°24′E) which is a left bank cutting 4 m high (Fig. 1).

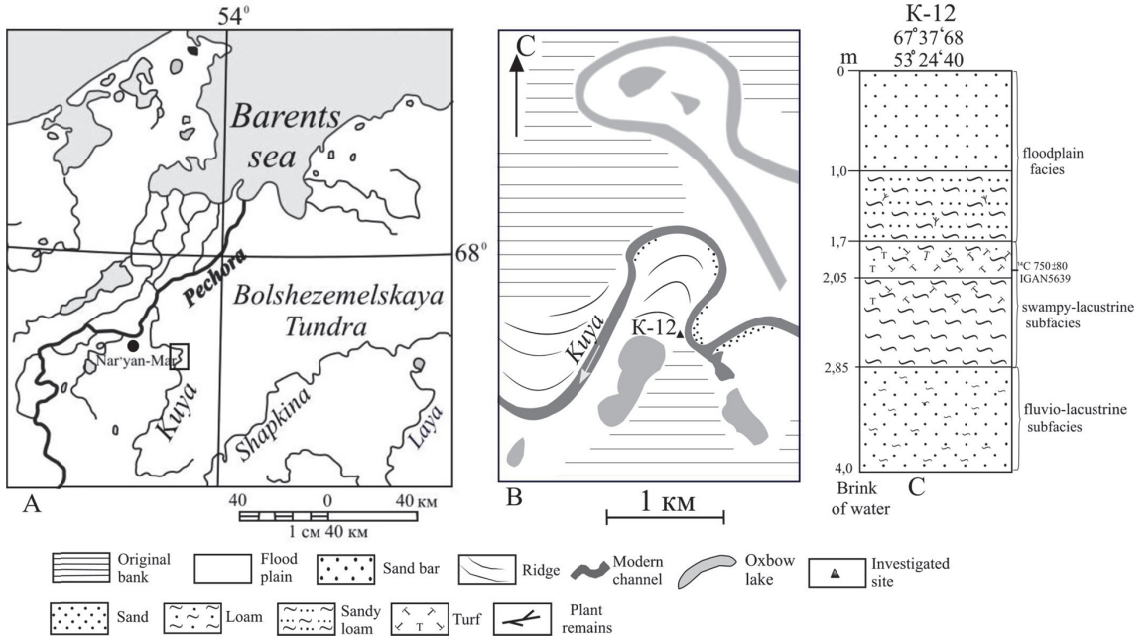

Fig. 1. The Kuya 12 site
A. Location of the investigation site. The study area is shown with square
B. Geomorphological scheme of the site
C. Lithological composition of the Kuya 12 section

The sediments are composed of flood plain and oxbow-lake facies (fluvio-lacustrine and swampy-lacustrine subfacies). The fluvio-lacustrine subfacies is the bottom of sedimentary beds (depth 2.85 – 4 m) and composed of grey fine-grained clayey sand. These deposits formed in flowing water reservoir, when an initial lake was connected with a channel. The lowermost sediments contain spectra (pollen zone K12-I, 4-2,65 m; Fig. 2) showing the coldest climate during the studied interval. The spectra are dominated by *Betula* sect. *Nanae* and Poaceae pollen. High amount of Bryales spores is also characteristic. The spectra composition indicates the development of a dwarf-birch tundra at the beginning of the Subatlantic period.