Reconstruction of Zone Vegetation, Bogs and Climate in Holocene by the Data of Two Contrast Vertical Peat Profiles (West Siberia)

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ABSTRACT. The peatlands and dry lands development history of vegetation within Ob-Vasugan watershed is characterized. According to the features of plant communities, climatic changes revealed by stratigraphic, spore-pollen and carbon data of two contrasting vertical peat profiles, the paleoecological environment changes in the last 10,000 years can be divided into five periods. The climate was characterized in Holocene according to these periods. Bog-forming process started in Holocene: on watershed about 9510 years BP, in Ob River valley - 8525 years BP. The rate of peat accumulation within watershed was slowly decreasing - from 1.9 to 0.3 mm/year; in Ob River valley, on the contrary - increasing from 0.1 to 0.5 mm/year.

KEY WORDS: Holocene, succession, reconstruction, stratigraphic peat profile, peat accumulation.

Introduction

As it is well known, the ombrogenous mires cover both uplands and valleys of the rivers. Dependent on geomorphological location, mires differ with character of peat accumulation, coenotic evolution and display climate change in a different ways. However the researches, which show the dependence of palynological-climatic data received upon a geomorphological location of a vertical peat bog profile, in particular whether it is incorporated within watershed or in river valley, are insufficient.

We carried out comparative research of two vertical peat bog profiles. The first one named "Vodorasdel", with geographical coordinates 60°31'N and 77°41'E, is incorporated in hollow of oligotrophic hummock ridge-pool complex within Ob - Vasugan watershed. Capacity of peat deposit makes up 550 cm. The second one named "Nasino", with coordinates 60°31'N and 77°41'E, is in a natural peat stripping on the right coast of Ob River near the village Nasino. Capacity of peat stripping is 400 cm. An oligotrophic pine-dwarf scrub-sphagnous facies (Sphagnum fuscum complex) arrange round the peat stripping.

Research methods

The peat depositions have already been a subject of vegetative cover and climate in Holocene reconstruction for almost a half-century now. The basic methods of reconstruction are spore-pollen, botanical and radiocarbon analysis of peat. Drilling and selection of peat samples were implemented through a continuous stratigraphical column every 25 cm in peat profile "Vodorasdel" and every 20 cm in stripping "Nasino". The preparation of peat samples for spore-pollen analysis was carried out by Gritchuk et al. (1948) method. Both the definition of floristic composition and calculation of pollen and spores were carried out by microscope MBI-6 at magnify of object in 200 times. The preparation of peat samples for the botanical analysis was carried out by peat samples boiling in 10% solution of NaOH during 10–15 minutes, followed by washing. For pollen, spores as well as peat-forming vegetative residues identification the various atlases, applied for peatland science, were used. The definition of peat deposition age based to ^{14}C dating was carried out with the help of radiocarbon installation in V.N. Sukachev Institute of Forest, Krasnoyarsk, Russia. The characteristic of paleoclimate was performed according to Klimanov (1976, 1985) technique. The technique allows differentiate climatic conditions within the investigated territory during Holocene to within degree of temperature and mm of precipitation.

Discussion of the results

We consider the results of botanical and spore-pollen analysis of peat within the limits of Blitt-Sernander periods and briefly interpretate the data which reflect vegetative successions along the bogs and dry lands connected with curves of some climate parameters deviations compared to up-to date ones.

The reconstruction of plant successions and climate based on the data of peat profile "Vodorasdel"

Predboreal (PB_2) - 550–440 cm. In the beginning of the period the bog was taken up by eutrophic horse tail facies, later - by swamp-subor forest. Dry lands at first were occupied by tundra-forest at fall of temperature -3.4 °C less compared to up-to date norm. Later, in the second half of PB_2 - dry lands were taken up by taiga with fern like plants in living soil-cover, that was connected with damp rise of temperature -1.8 °C more compared to up-to date norm. During PB_2-BO contact again dry fall of temperature -3 °C less with respect to up-to-date norm took place. An average rate of peat accumulation makes up 1.92 mm/year.

Boreal (BO) - 435–350 cm. Vegetation change, illustrated by peat stratigraphy of the period looks as follows: bogged forest → open hypnum mire → mezo- and oligotrophic sphagnum bog. Automorphic forest density increases, dark coniferous species share enlarged in tree structure, and taiga forests begin to occupy dry lands. The dry fall of temperature happens, then humid rise of temperature takes place followed by dry fall of temperature again. It was an important climatic limit, which was followed by gradual rise of temperature and humidity right up to the middle of AT_2 - the climatic optimum. An average rate of peat accumulation makes up 0.97 mm/year.

The Atlantic period (AT) - 350–150 cm. In first half of period (AT_1 - 350–250 cm) the bog ridge-hollow oligotrophic com-

plex reached the maximum development. Dry lands were occupied by spruce taiga. The uniform gradual downturn of temperature with 1.8 up to 0.9 °C less with respect to modern norm was marked. An average rate of peat accumulation amounts 0.68 mm / year. In the second half of period the bog got dried, that was resulted in replacement of ridge-hollow complex by pine-cotton-grass-sphagnum coenosium. Pine, cedar and firtree were the main forest species that grew along dry lands. The middle of AT_2 (5900–5500 years BP) - climatic optimum - was warmer -1.0 °C and precipitation's 20 mm more compared to modern norm. In the end of AT_2 the dry fall temperature (1.4 °C and 25 mm of precipitatons less compared to modern norm) took place, which, probably, resulted in significant reduction of fir-tree forest-forming role. An average rate of peat accumulation amounts 0.57 mm/year.

Subboreal period (SB) - 150–75 cm. The bog was taken up by the same pine-cotton-grass-sphagnum coenosum but dry lands - by dominating taiga. However in paleoclimatic respect the period was non-uniform.

SB_1 - 150–125 cm. The significant subboreal rise of temperature took place which caused the origination of so-called "boundary horizon" widely observed in European peat-bogs. In Siberia occurred the rate decrease of peat accumulation. Dry lands were taken up by grassy high dense forests with Siberian pine dominating.

SB_2 - 125–100 cm. Dry lands were occupied by moderately dry herbaceous Siberian pine forests. There was the intermediate state between the upper subboreal rise of temperature and lower subboreal fall of it.

SB_3 - 100–75 cm. Taiga Siberian pine forests were prevailing within dry lands. In the spore-pollen spectrum the amount of dwarf birch enlarged sharply, but the amount of grasses decreased. Dry fall of temperature took place. An average rate of peat accumulation in SB - 0.31 mm/year.

Subatlantic period (SA) - 75–0 cm. The bog was taken up by hummock-ridge complex again. The pollen spectrum of trees is formed by Siberian pine, birch and pine nearly equal. As it has been already mentioned (Glebov, 1988; Glebov and Karpenko, 1999), the amount of pine pollen increases in the spectrum when moving up the peat profile which witnesses that the bog entered the oligotrophic phase and pine was prevailing tree species on the bog. However, within dry lands the Siberian pine must be considered as the dominating species. The wave of temperature wet rise crossed through the period. According to spectrum data of the upper sphagnum moss sample (0–15 cm), obtained from the bog hollow water, the new rise of temperature is awaited shortly after. An average rate of peat accumulations through the whole period is 0.31 mm/year.

The reconstruction of vegetation and climate successions based on the data of peat profile "Nasino"

Boreal period (BO) - 400–315 cm. The botanical analysis of peat stratigraphy reveals a complex number of facies successions within the bog: eutrophic swamp subor → mesotrophic sedge-cotton-grass facies → oligotrophic pine-dwarf-shrub sphagnum complex. In valley of the river birch-dark coniferous forests dominated, within dry land - first forest tundra, later - taiga. This phenomenon was promoted by lower-boreal rise of temperature (2.4 °C less compared to modern norm.). An average rate of peat accumulation through the whole period amounts 0.79 mm/year.

The Atlantic period (AT) - 315–200 sm. In the first half of period (AT_1) the bog was engaged by fuscum-riam. In valley of the river birch-dark coniferous forests were prevalent, within dry lands - taiga forests. Up to the middle of AT_1 there was observed a fast increase of temperature (from 2.0 °C less up to 0.3 °C more compared to modern norm.) and precipitation's -40 mm more with respect to modern norm. Then there was an appreciable downturn of these parameters. In the second half of AT_2 period the former vegetation was observed on the bog and in river valley as well as within dry lands. It is necessary to note the increase cedar share in forest structure and the reduction of spruce and pine. The participation of birch in forest forming reaches the maximum. The important feature of AT_2 period - is forming of forests with significant participation of fir-tree. The climatic optimum of Holocene is expressed poorly on the diagram. An average rate of peat accumulation amounts 0.15 mm/year.

Subboreal period (SB) - 200–135 cm. Within the bog the fuscum-riam was replaced by pine-cotton-grass-sphagnum grouping of vegetation. In river valley and within dry lands the former vegetation was observed. The reduction of birch role and the increase of cedar and pine role in forest forming process took place. Spruce-tree and cedar were not widely spread. Paleoclimatic curves are monotonous, which may be explained by levelling influence of large river valley climate upon zonal climate. An average rate of peat accumulation makes up 0.38 mm/year.

Subatlantic period - 135–0 cm. Facies structure was the next: fuscum-riam within the bog, birch-dark coniferous forests within river valley, taiga in dry lands. Paleoclimatic curves show a weak fall of temperature in the beginning of the period and heavy damp rise of temperature at the end. A modern tendency of climate is dry fall of temperature. An average rate of peat accumulation makes up 0.56 mm/year.

Conclusions

According to Blitt-Sernander periods the differences of the profiles are shown in 1) plant succession within bogs and dry lands; 2) paleoclimatic curves of annual temperatures. The extreme of moist warm - climatic optimum took place in Ob-Vasugan watershed 5500 years ago. While in the second terrace Ob River it began earlier - 7000 years ago. The phenomenon can be explained by the fact that climate of watershed was more continental, compared to climate of great river valley. As a whole, peaks of warming and fall of temperature received are on age coincide with available for the other regions of Russia. The warming took place about 10,000, 9100, 9000, 8500, 7100, 6700, 6000, 5500, 4600, 3500, 2200, 2000, 1800, 1000 years ago.

The falls of temperature are marked 9500, 8800, 8300, 6900, 6400, 5800, 5100, 4200, 2500, 1900, 1500 years ago.

Peat accumulation rate in the watershed profile is decreasing steadily and smoothly (obviously, everything what could be bogged up that has been already bogged up), which allows to make mathematical modelling of peat - and carbon accumulation and to make a prognosis that the process will stop in 1000 years. What concerns the peat profile, located in Ob River valley, the peat accumulation, on the contrary, is increasing, which allows consider peat depositions like that perspective for detailed climatic prognoses.

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Molluscan and Pollen Assemblages from the Ochozská Cave as Climate Indicators for the Late Glacial and Holocene (Moravian Karst, Czech Republic)

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ABSTRACT. Land molluscs are competent group of invertebrate animals available for appreciation of natural conditions in karst areas. Reconstruction of the landscape and vegetation development in the southern part of the Moravian Karst was based on the investigation of molluscan thanatocoenoses and pollen assemblages. Late Glacial/Holocene boundary was assigned in the correlation with sedimentary dynamics.

KEY WORDS: molluscs, pollen, climate indicators, landscape, Late Glacial, Holocene, Moravian Karst, Czech Republic.

Introduction

This paper deals with reconstruction of the landscape and vegetation development in southern part of the Moravian Karst - the most important karst region of the Czech Republic. The reconstruction consists in the analysis of the land mollusc's thanatocoenoses and pollen assemblages extracted from slope deposits. Because land molluscs are with their relative immobility and close connection to substrate important indicators of landscape conditions, it is possible to reconstruct figure of natural landscape in the correlation with sedimentary dynamics, using their fossil remains in calcareous deposits. Molluscs appear to be an ideal faunal group for studies of landscape development.

Methods and material studied

As the representative site in the southern part of Moravian Karst was investigated area in the Říčka Valley near Ochoz Village. Studied section (Fig. 1) in slope sediments was exposed below the limestone cliff near the Ochozská Cave entrance. This section captures Late Glacial and Holocene sequence represented by nine sedimentary layers. Mollusc's thanatocoenoses selected from individual layers of the profile by means of usual method (Ložek, 1964) was studied, assorted, determinated and statistically estimated.

From the same section eight samples for palynological study were taken. All samples were formed by the highly minerogenic sediment with a great content of calcium. The method of the minerogenic separation with heavy liquid (Thoulet solution - CdJ_2+ KJ) of the density 2g/cm³ was used. The pollen was cumulated from the amount of 50 grams of the material per one sample. The pollen grains in the glycerin medium were observed. From the each sample about 10 slides were counted to obtain 100 pollen grains, at least.

Results and analyses

The main results acquired from palaeontological content of individual layers are summarized in the transparent Table 1. Table also summarizes important sedimentological features and reconstruction of landscape with chronology.

The profile through the deposits below the limestone cliff involves 9 layers of slope deposits that can be divided into 4 groups with certain specific properties.

A basal series (layers 9–6) are very pure in mollusc's thanatocoenoses. Material consists of fine debris and large blocks with non-humous massive clayey silt including species with wide ecological valence that are able to sustain rough climatic conditions (e.g. *Pupilla muscorum* (L.), *Vallonia costata* (MÜLL.), *Clausilia dubia* DRAP.). The structure of species corresponds to the open landscape with climatic conditions of Glacial-Late Glacial stage.

The overlying beds (layers 5 and 4) are represented by deposits with greater portion of limestone debris. Malacofauna consists of scrubs and open landscape species, appearing species *Discus ruderatus* (FÉR.), *Semilimax kotulae* (WEST.) and *Vertigo substriata* (JEFFREYS) indicate occurrence of little dampe and forestry facets still embosomed with open ground (layer 5) The following overlaying bed (layer 4) is enriched in forestry species (e.g. *Cochlodina laminata* (MTG.), *Cochlodina orthostoma* (MENKE)) or hygrophilous *Carychium tridentatum* (RISSO), demanding more covered and damper facets. The culmination of *Discus ruderatus* (FÉR.) (layer 4) is characteristic fo