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SPATIAL DYNAMICS OF PEAT GROWTH AND CARBON ACCCUMULATION IN SPHAGNUM BOGS (BOREAL WEST SIBERIA)

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Spatio-temporal dynamics of carbon accumulation in the peat deposits of the peatlands in the Middle taiga zone were investigated on base of measurements in an representative peat bog 'Savkino' near Nizhnevartovsk town (61°16′ N, 7°32′ E). This bog is situated on the right bank terraces of the Vakh River at the confluence of the Vakh and Ob. The bog has started to develop about 10,000 years BP via paludification of several topographical depressions with waterlogged soils or from shallow water bodies within the wide ancient glacial run-off water track.

Nowadays the main part (about 75%) of the peatland is covered by vast ombrotrophic ridges-hollows and ridges-hollows-pools complexes. The minor part of the area (about 15-20%) is covered by pine-dwarf shrub-*Sphagnum* communities ('ryams'). About 5-10% of the whole area is occupied by open sedge-*Sphagnum* peripheral fens, which have been developed along the upland boundary and around the mineral islands in the bog. These are the zones in which modern paludification processes take place.

MATERIALS AND METHODS

Along a cross-section through the peatland, 18 cores have been carried out, from which peat samples (10 cm thick) were collected from the entire depth of peat deposits for macrofossil plant remains analysis. On the basis of those analyses the maccrofossil plant remains composition in the peat cores have been discovered for the entire depth of the peat deposits. Also the peat stratigraphy for the whole cross-section has been recorded on the basis of these studies.

In 15 peat cores peat bulk density were determined. On the basis of that information the carbon storage in all layers of the peat cores could be calculated[1].

In the cores the radiocarbon analysis has been executed on all basal peat samples, and also in the peat layers on a depth of 50 and 200 cm. In the deepest peat core, located in the central part of the peatland, the radiocarbon age was determined for every 50 cm.

RESULTS

The peat accumulation started between 10,300 and 9,200 yr. BP. It is evident, that about 2000 years after peat initiation, the bog had been expanded almost as far as its present-day area. Only narrow marginal parts of the bog became covered with peat in the last 1170 yr. BP.

On the basis of the elevation of the mineral bottom at different sites on the cross-section, the age of the beginning of peat deposition, as well as

[1] The value of carbon content in organic matter of peat is accepted on S.P.Yefremov et.al. (1994) for ombrotrophic, transitional and minerotrophic peat accordingly.

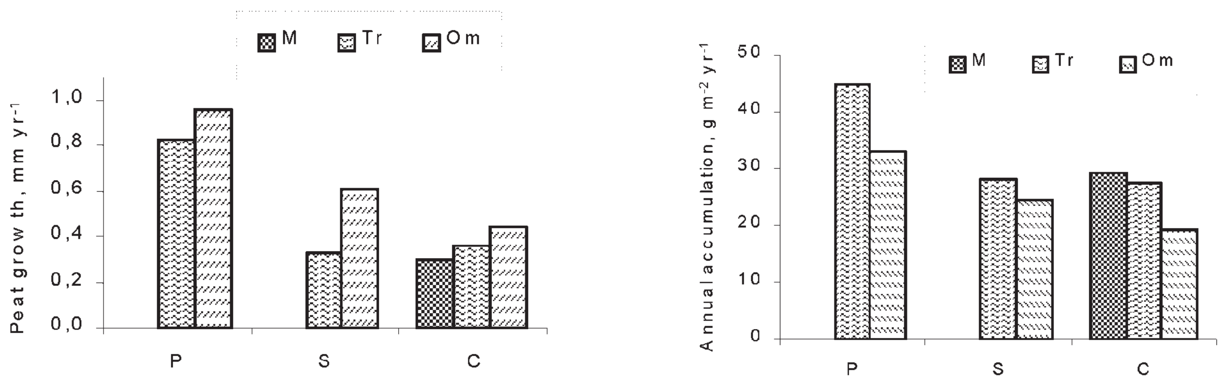

***Figure 1**. Average rate of peat growth (A) and carbon accumulation (B) in the different stage of bog development depending on the spatial position within the peatland.*

Stage of bog development (peat type): M – minerotrophic fen, Tr – transitional bog, Om – ombrotrophic raised bog.

Spatial positions: P – Periphery, S – Slope, C – Centre.

essential features of peat stratigraphy, the whole peatland area could be divided into 3 main parts/ positions: 1 – Centres of origin of peat accumulation, 2 – adjoining Slopes, 3 – Periphery. For each peat core belonging to one of the three types were determined the fossil plant remains sequences, the rate of peat and carbon accumulation in relation to their position within the peatlands. Locations with maximal peat thickness, mainly 4.0-5.0 m, have been characterized as peat deposits from the genetic centres. The peat depth on slope positions, where the accumulation of peat started about 1,000-1,500 years later, differs insignificantly, usually between 3.6-3.8 m. The minimal depth of peat in the periphery is 0.6-1.2 m.

The peat deposits in the genetic centres contain mostly poorly (0-5 %) up to moderately decomposed (10-25 %) ombrotrophic *Sphagnum fuscum* peat. In bottom part there is an alternation of *Sphagnum* (*S. fuscum, S. angustifolium*) and cotton grass (*Eriophorum vaginatum*) layers. The basal peat layer, with a thickness 20-60 cm, is composed of wood-herbaceous and herbaceous peat from the remains of spruce, birch, horse-tall and fern. The degree of decomposition of this layer reaches 60-65%. The transitional horizon between lower minerotrophic and upper ombrotrophic peat layers at the genetic centers usually does not exceed 10-20 cm, the maximal thickness is 50 cm. This layer is composed, as a rule, by transitional cotton grass peat.

The peat deposits in the slope positions, adjoining to the genetic centres, have an age of 7,300-8,000 yr. The peat deposition here started directly with transitional peat, usually cotton grass peat, which thickness reaches about 50-60 cm. The upper part of the peat deposits has been composed of ombrotrophic *Sphagnum* peat, as well as at the genetic centres.

The peripheral parts of the peatland have started to develop between 2,300 up to 900 yr. BP. The peat deposits along the border of the uplands are fully composed of transitional cotton grass-*Sphagnum* peat. In lagg fens surrounding the mineral islands the deposits are composed of both transitional and ombrotrophic kinds of peat. On a general background of climatic changes during the Holocene and their influence on the process of peat accumulation, the rate of peat growth and accordingly the carbon accumulation rate appreciably differs for the different time periods, depending on the type of peat (fossil plant remains composition) and the site position within the peatland (Fig.1 A, B).

The rate of a vertical growth of minerotrophic and transitional peat in the genetic centres varied over a wide range from 0.23 till 0.56 mm yr^{-1} depending on the type of peat that was deposited. The maximal

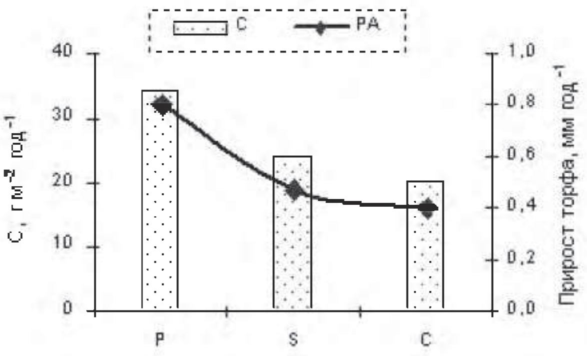

Figure 2. *Average rate of carbon accumulation (C) and peat growth (PA) on the different spatial positions within the peatland.*
Spatial positions: P – Periphery, S – Slope, C – Centre.

values (0.48-0.56 mm yr^{-1}) of vertical peat growth have been caused by the accumulation of transitional cotton grass peat. Smaller values of peat growth (0.23-0.31 mm yr^{-1}) occur at the accumulation of minerotrophic fern and wood-cotton grass peat. The rates of ombrotrophic peat accumulation at the genetic centres were rather uniform at all investigated points and varied from 0.41 till 0.50 mm yr^{-1}. At the slope positions the intensity of growth of transitional and ombrotrophic peat was appreciably higher, than of peat deposits of the genetic centres. For the transitional type the rate of peat accumulation was 0.21-0.56 mm yr^{-1}. In ombrotrophic peat the values of peat accumulation rate varied from 0,43 up to 0,73 mm yr^{-1}. On the periphery the rate of vertical peat growth (transitional and ombrotrophic) differed considerably more from the peat growth in the main part of the peatland (Fig. 1, A). After having examined the carbon accumulation rate in various types of peat in relation to the position within the peatland the following regularity could be recognized.

In the genetic centres, during the initial stages of peat accumulation, minerotrophic peat has been deposited. The average rate of carbon accumulation in it was 29.3 g C m^{-2} yr^{-1} (with a range 23.3-34.6). In transitional peat layers in the genetic centres the rate of carbon accumulation has been a little lower, on the average up to 27.4 g C m^{-2} yr^{-1} (Fig. 1, B). Transitional peat types on the slope positions show similar values for the rate of carbon accumulation. On the periphery of the peatland in the transitional peat layers the carbon accumulation rate per year was maximal 44.7 g C m^{-2} yr^{-1}.

The values of annual carbon accumulation rate in the ombrotrophic part of the peat deposit are appreciably different for the different types of positions (genetic centres, slopes, and periphery). The lowest carbon accumulation rate 19,2 g C m^{-2} yr^{-1} (with a range 14.6-24.5) has been found in the ombrotrophic peat layers in the centres. Noticeably higher it was on the slopes 24.6 g C m^{-2} yr^{-1} (20.4-32.2) and maximal carbon accumulation rates have been found on the periphery: on the average 33,0 g C m^{-2} yr^{-1} (32.9-34.8) (Fig.1, B).

The similar regularity was discovered for the average long-term rate of peat and carbon accumulation calculated on the basis of the total peat deposits (Fig. 2).

CONCLUSIONS

Intense accumulation of peat and development of a typical bog at Middle Taiga zone during Holocene was determined by favorable climatic and geomorphological conditions. Dense peat with high contents of carbon was accumulated at initial stages of development of minerotrophic and transitional bog. Rate of vertical growth of the bog have increased at ombrotrophic stage of development, but the carbon accumulation rate have decreased due to of low of density sphagnum peat. The modern expansion of the bog to adjoining waterless valleys is carried at raise of water table and high rate of vertical peat accumulation on bog periphery. Thus in the central parts of bog there is a decrease of vertical peat growth.

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