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DEPTH DISTRIBUTION OF METHANE PRODUCTION AND OXIDATION IN A SPHAGNUM PEAT BOG

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The anaerobic production and potential aerobic oxidation of methane were assessed in a *Sphagnum*-dominated peatland in Sweden. Peat from four depths in the 0–40 cm (below the vegetation surface) layer was collected in three different plant communities. The rate measurements were made with peat slurries in flasks. The ratio between the mean production and mean oxidation activities was more than ten-fold higher in the two wetter than in the driest community. The within profiles depth distributions of methanogenic and methane-oxidizing activity were similar, showing that a particular level may act as a net source or a net sink for methane, depending on prevailing environmental conditions (primarily the oxygen distribution). The results also suggest that methane production and consumption processes can occur in anaerobic and aerobic microzones in very close proximity to each other.

Key words: Carbon flow, methane oxidation, methane production, peatlands

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INTRODUCTION

The rates of methane emissions from wetlands are dependent not only on the production of methane, but also on its oxidation by methanotrophic micro-organisms in the aerobic parts of peats or sediments. Thus, the emission rates are net rates resulting from the balance between production and oxidation processes. The aim of this study was to examine the relation between methane production and potential methane oxidation in some habitats differing in water table position and methane emission rates. Peat samples were collected from a largely ombrotrophic, temperate, *Sphagnum*-dominated wetland in northern Sweden.

MATERIALS AND METHODS

Sampling

The driest habitat sampled was a hummock dominated by *Sphagnum fuscum*, with low stands of *Pinus silvestris*, and the wettest habitat an area of *Sphagnum* derived peat covered with a liverwort ("mud-bottom"). The third community was a slightly raised string dominated by *S. fuscum*, where the water table level was intermediate compared to the other communities. Samples for the production assay were immediately transferred to bottles which were made anaerobic by flushing with nitrogen in the field.

Incubations

In the laboratory, the production bottles were evacuated and refilled with nitrogen three times and then incubated at 24°C with shaking. The methane production rates were calculated from the headspace concentration after 5 days of incubation. For the oxidation assay, peat samples were transferred to bottles which were subsequently evacuated and refilled with air three times. Methane was added to a headspace concentration of

0.3% and the bottles were incubated as already described for the production assay. The methane concentration in the flasks was measured regularly during ca. 15 hours and the initial rate of consumption was used as a measure of methane oxidation.

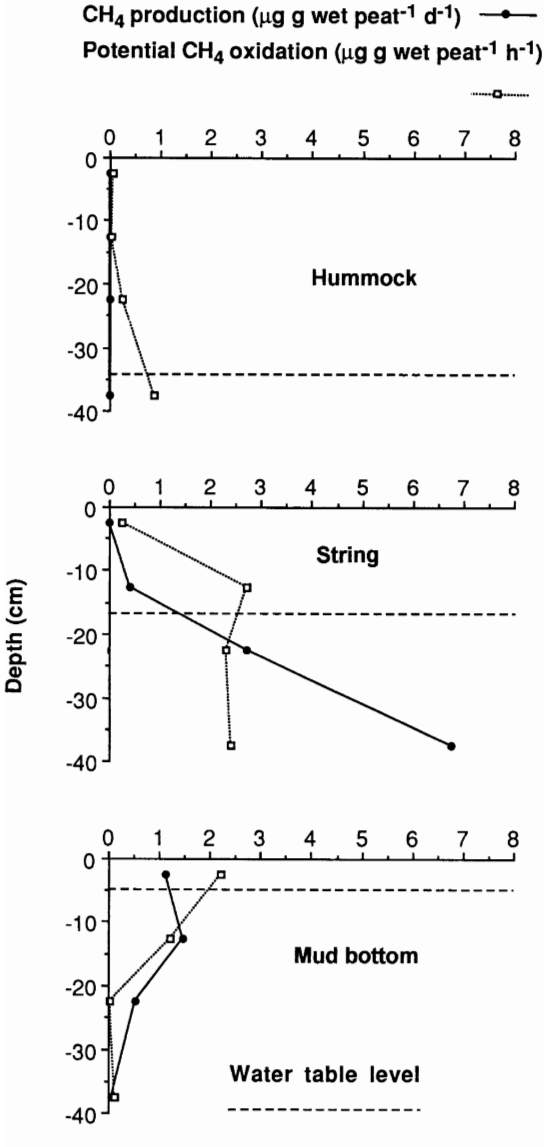

Fig. 1. Depth profiles of methane production and oxidation for three habitats of a *Sphagnum*-dominated wetland as measured in laboratory flask incubations of peat.

RESULTS AND DISCUSSION

In the mud-bottom habitat, production was highest in the upper layers and decreased with depth. In the hummock and string habitats, on the other hand, production was lowest at the surface and increased with depth (Fig. 1). Only a very small part of the methane production occurred above the water table in the two latter habitats. The mean production rates were ca. 2 orders of magnitude higher in the mud-bottom and the raised string compared to the hummock.

In all three communities, the highest rates of potential methane oxidation was found close to the water table. Thus, in the mud-bottom community, the oxidation was highest at the surface, whereas in the other two habitats, the oxidation was highest at a few dm depth (Fig. 1). This finding is in agreement with the general view that highest numbers of methane oxidizing organisms occur at anaerobic/aerobic interfaces, where high supplies of oxygen and methane meet. The mean oxidation rate for the 0–40-cm layer was several times higher in the mud-bottom and the raised string than in the hummock.

The ratio between the mean production and mean oxidation of methane for the 0–40-cm layer was much lower in the comparatively dry hummock than in the two other habitats (Table 1). This lower production/oxidation ratio is compatible with the methane emission rates from this habitat. Thus, the emission rates from the hummocks were among the lowest found in any habitat in this wetland. The mean production and oxidation rates, as well as the ratios between them, were similar in the other two habitats (Table 1). The comparatively high methane production in the string was unexpected, since methane emissions were almost two orders of magnitude higher from the mud-bottom than from the *S. fuscum*-dominated strings. A possible explanation may be the spatial variation in methane emissions, because the samples for the production/consumption assays were taken at some distance (at least 1 m) from points of emission measurements.

SUMMARY AND CONCLUSIONS

(1) Most methane production occurred in the water-saturated zone, with only a very small fraction produced in the aerated zone. (2) Maximal rates of potential methane oxidation were, in most cases, found close to the position of the water table. (3) The depth distributions of both the pro-

Table 1. Rates of methane emission and ratio between production and consumption of methane in three different habitats of a *Sphagnum*-dominated wetland.

Habitat	Water table position, cm below veg. surface	CH_4 prod./cons. ratio	Emission, mg CH_4 m^2d^{-1}*
Hummock	34	0.0084	2.2
String	17	1.29	2.3
Mud-bottom	5	0.896	196

*Mean of three measurements made in June, July and September.

duction and oxidation of methane vary much among habitats, and they seem to largely be determined by the level of the water table. (4) In many cases, one peat sample showed comparatively high rates of production when incubated under anaerobic conditions and of oxidation when incubated under aerobic conditions. This suggests that peat from a particular layer in the profile may act as a net source or a net sink for methane, depending on the prevailing environmental conditions (primarily the oxygen distribution, which is in turn determined by the position of the water table).