Cattle dung can increase CH_4 production and influence the methanogen community of rewetted peat soils

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Background

Rewetting of drained peatlands aims to recover the biogeochemical processes typical to pristine peatlands. This includes an increase of CH_4 emissions.

The potential for very high emissions has been measured in Central-European peatland sites previously used for grazing of cattle.

Experimental approach

We wanted to find out if high CH_4 emissions from rewetted peatland sites could be explained by previous land use as cattle pasture.

We analyzed the effects of dung application (DA) to peat soil on the methanogenic potential and community in three different experimental approaches (Fig.1):

a) DA treatment of peat soil in the laboratory
b) applying dung to three restored and one pristine peatland in the field in Finland
c) sampling a restored peatland influenced by cattle pasture in Germany

Figure 1. Dung application (DA) treatments were examined in a laboratory experiment (a), a field experiment (b) and at a peatland site with cattle pasture (c).

Measured variables

We measured CH_4 production potentials (Fig. 2), determined the numbers of methanogens by *mcrA*-qPCR (Fig. 3) and analyzed the methanogen community by *mcrA* T-RFLP-cloning-sequencing (Fig. 4; Tab. 1)

Results

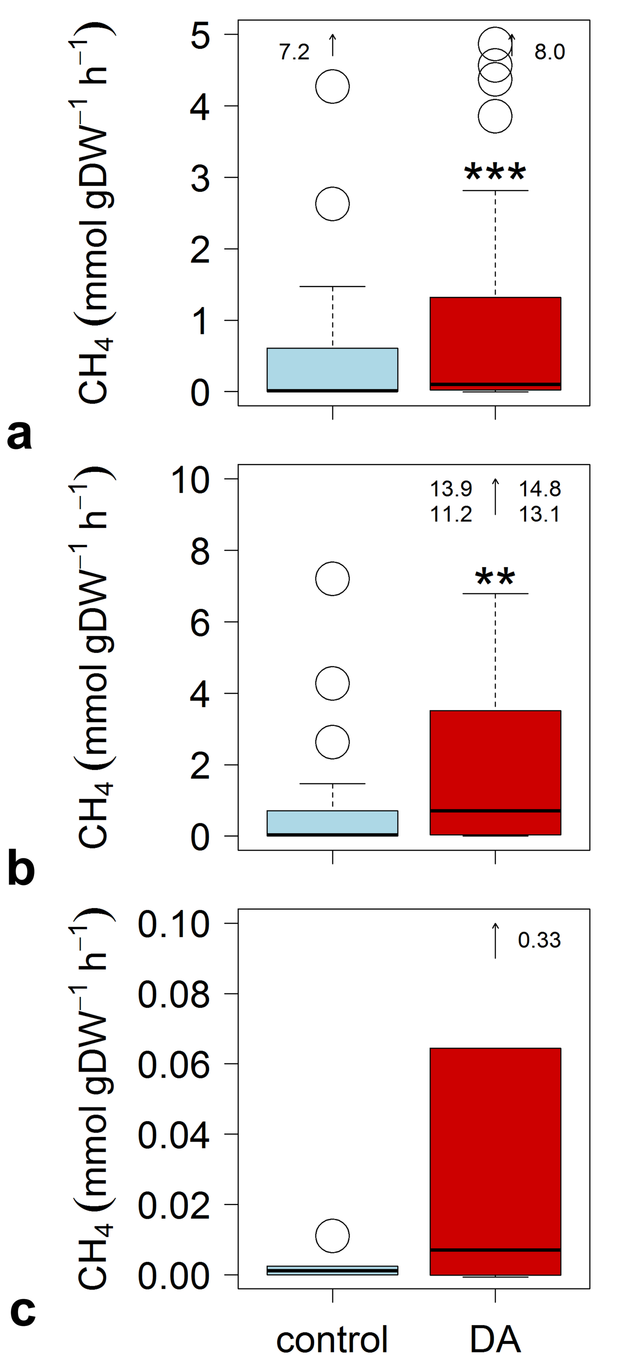

Figure 2. Increase of CH_4 production potential after dung addition in the laboratory (a, n=84) and field experiment (b, n=72) and at the cattle pasture (c, n=11).

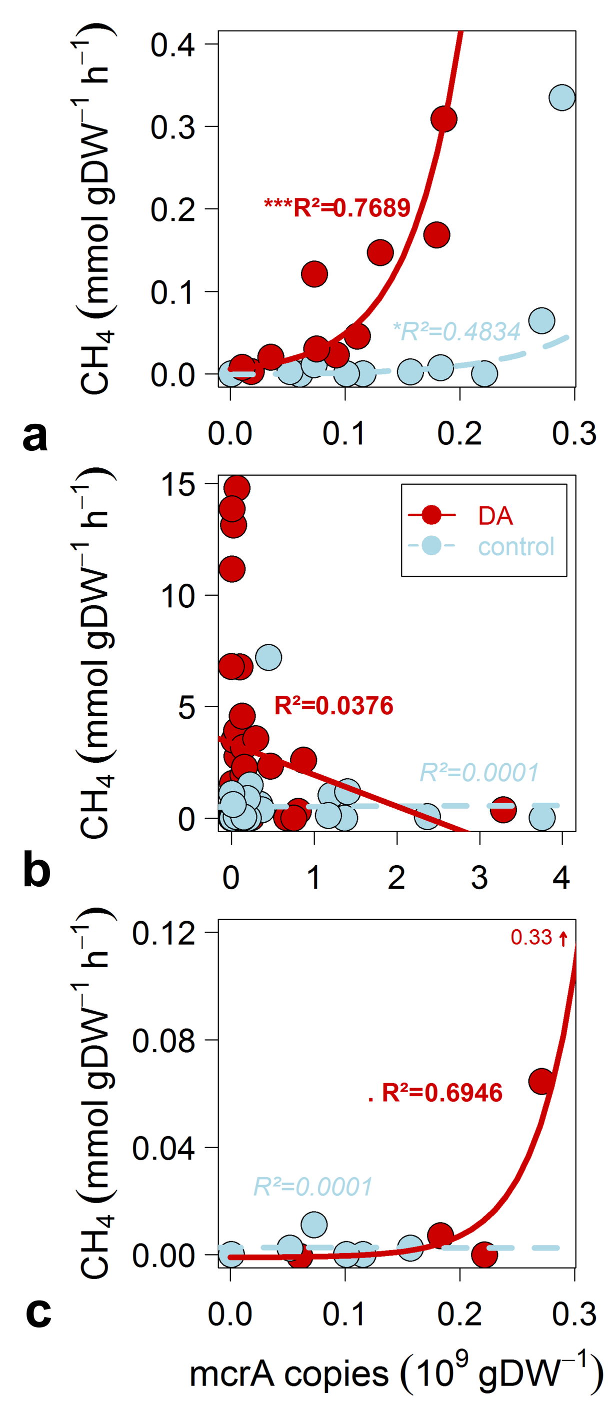

Figure 3. Correlations between CH_4 production potential and *mcrA* gene copy level in the laboratory (a, n=21) and field experiment (b, n=72) and at the cattle pasture (c, n=11).

mcrA T-RF (bp)	laboratory experiment	field experiment	cattle pasture
79		C, D, DA	C
86		C, DA	C, DA
97		C, DA	
101	DA	C, DA	DA
106	**D, DA**	**D, DA**	**D**
108			C
119	D	D	D
132		C, DA	
141	DA	C, D, DA	DA
152		C	
160		C, DA	
199		C, DA	DA
210	DA	C	C, DA
214	D, DA	C, D, DA	C, D
220	DA	C, DA	DA
232	DA	C, DA	C, DA
237		C	D, DA
257			C
292		C, DA	
371	D, DA		D
380		C, DA	DA
389		DA	
395	DA		DA
399		DA	
406		C, DA	DA
473		C, DA	C, DA
492	DA	C, DA	C, DA

Table 1. Occurrence of *mcrA* TRFs in the samples of dung (D), control peat (C) and peat with dung application (DA) from the laboratory experiment, field experiment and the cattle pasture. There are no unique control samples for the laboratory experiment as we added fresh dung to the samples from the pastured site for laboratory DA. The very same dung samples were used in the laboratory experiment and the cattle pasture. The green *mcrA*-T-RF species was found only in dung and has no match to known methanogens. The red *mcrA*-T-RF species were found in dung and dung-treated peat, only. The T-RF with 106bp length matches with *Methanobrevibacter* species found in 70 % of all dung sequences.

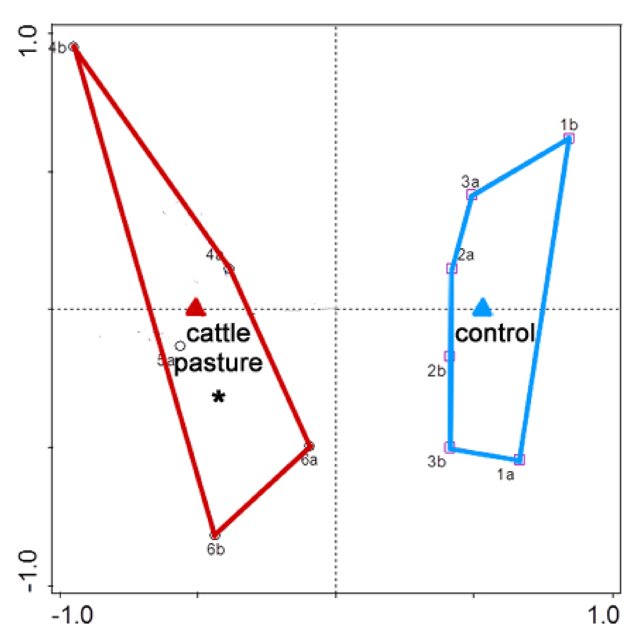

Figure 4. DCA of *mcrA* T-RF's showing the separation of the community of methanogenic archaea between the control site and the site having cattle pasture in Germany.

Conclusions

We found a shift in methanogen community due to DA and a sequence transfer of dung methanogens to the peatland soils. Both might have caused the higher CH_4 production potentials after DA.

Our findings indicate that rewetting of peatlands that have been previously grazed by cattle might lead to increased CH_4 emissions.

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