Effects of microtopography, root exudates analogues and temperature variation on CO_2 and CH_4 production from fire-degraded tropical peat

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Background

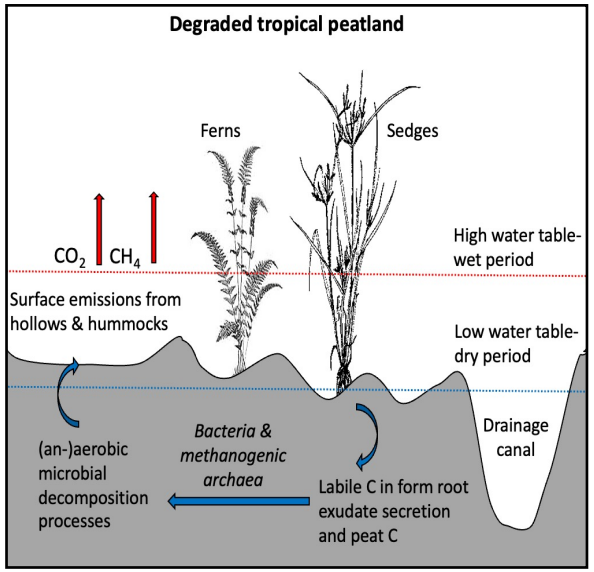
- Tropical peatlands degraded mainly by drainage and fire
- Extent increased to almost 10% (~1.42 Mha) of the total peatland area in SE Asia
- Altered microtopography may regulate water-saturation conditions (oxic and anoxic)
- Higher temperature enhances peat oxidative decomposition leading to subsidence and flooding
- Change in vegetation can affect quality and quantity of root exudates, hence affecting CO_2 and CH_4 production and emissions

Approach

- Peat samples – fire-degraded tropical peatland, Brunei Darussalam (4°28'40" N, 114°18'19" E)
- Root exudates compounds (REC) – sedge and fern species (targeted analysis for sugars and organic acids)
- Incubation experiment set up –
  - ✓ 13 g peat incubated under three factorial design using 1 L mason jars
  - ✓ **Microtopography** creating water-saturation (mesic, flooded oxic with DI water, anoxic with DI water + bubbled with N_2)
  - ✓ **Root exudate analogues** in form of labile C (R-0.1, R-0.2, R3-0.3 g C/g of peat/day)
  - ✓ **Temperature variation** (26°C – night time; 30°C day time)
- Measurements – CO_2/CH_4 flux measured at time 0, 6, 12, 24, 72, 120 hours after addition of REC solution (GasScouter, Picarro Inc)

Findings

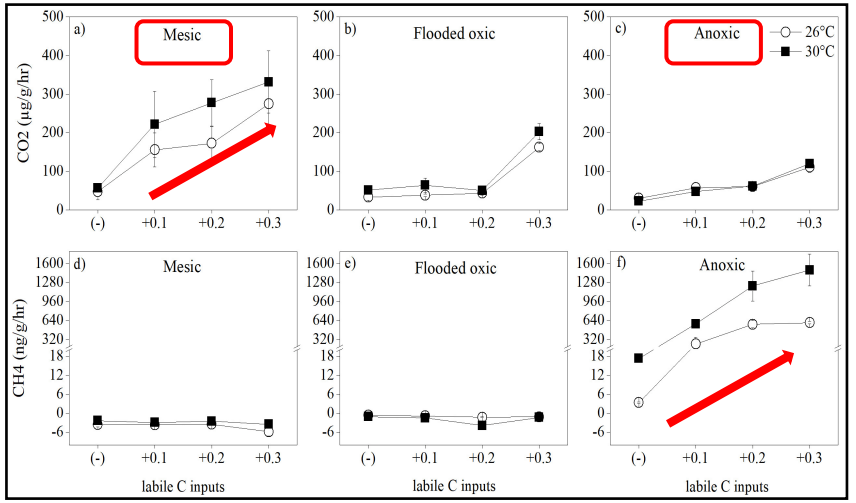
- Ferns and sedges secrete root exudates compounds with sugar: organic acid ratio of 2:1
- Water-saturation conditions, root exudates analogues, and temperature significantly ($p<0.05$) affected CO_2 and CH_4 production
- Mesic treatments acted as source of CO_2 (230.4 ± 29 $\mu gCO_2\ g^{-1}\ hr^{-1}$) whereas anoxic treatments acted as source of CH_4 (591.9 ± 112.1 $ngCH_4\ g^{-1}\ hr^{-1}$)
- Anoxic treatments showed higher temperature sensitivity (Q_{10}) for CH_4 (1.56 ± 0.35) whereas mesic showed higher sensitivity for CO_2 (1.21 ± 0.28)
- Prolonged dry conditions associated with the El-Niño may exacerbate fire re-occurrence and expand the extent of degraded tropical peatland



Condition	Mason jar setup	Night (26°C)	Day (30°C)
Mesic (Raised hummock)	Peat only	C, R1, R2, R3	C, R1, R2, R3
Flooded oxic (Shallow hollows)	Peat + water	C, R1, R2, R3	C, R1, R2, R3
Anoxic (Deeper hollows)	Peat + water + N2	C, R1, R2, R3	C, R1, R2, R3

Root exudates compounds

C compounds (µg/g)	*S. sumatrensis* (sedge; n=3)	*Blechnum indicum* (fern; n=3)
Fructose	68.25 ± 3.22	197.16 ± 0.28
Glucose	20.22 ± 0.50	45.14 ± 5.04
Acetate	4.38 ± 0.12	4.94 ± 0.13
Formate	1.07 ± 0.03	2.02 ± 0.25
Lactate	12.04 ± 0.20	3.31 ± 0.17
Malate	1.87 ± 0.08	0.32 ± 0.05
Oxalate	2.42 ± 0.01	5.57 ± 0.05
Succinate	3.00 ± 0.03	4.64 ± 0.12
Tartrate	17.47 ± 0.09	15.74 ± 0.05
Sugar: Organic acid	**2 : 1**	**2.4 : 1**



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