

Interactive comment on “Passive adsorption of neighbouring plant volatiles linked to associational susceptibility in a subarctic ecosystem” by Adedayo Mofikoya et al.

Adedayo Mofikoya et al.

adedayo.mofikoya@uef.fi

Received and published: 20 January 2017

Interactive comment on “Passive adsorption of neighbouring plant volatiles linked to associational susceptibility in a subarctic ecosystem” by Adedayo Mofikoya et al. Anonymous Reviewer #1 Received and published: 23 December 2016

General comments We thank Reviewer #1 for the succinct review and constructive comments. We have responded to all the comments in the subsequent paragraphs. We will consider incorporating the points raised in some of the comments during subsequent revision of the manuscript and where we cannot do this, we hope that we have been clearly able to express our reasoning.

C1

Reviewer Comment 1: This manuscript deals with a very interesting topic in chemical ecology: it describes the passive adsorption of plant volatiles in cuticles of neighbouring plants in an subarctic ecosystem and their subsequent re-emission from them, thereby possibly influencing the occurrence of herbivorous insects. Overall, the research topic is very timely, however, the present data set is very limited to draw a comprehensive conclusion whether absorbed and re-emitted volatiles of Rhododendron by mountain birch is related to associational susceptibility (AS) of mountain birch. Samples for VOC analysis were taken once in summer within a short (3 days) sampling period. I'm wondering why the sampling wasn't repeated several times to obtain a more comprehensive data set suitable for a more powerful statistical analysis.

Author's Response: We acknowledge that Reviewer #1 raises some important points here especially regarding the small dataset. However, it is important to note that data from this area is hard to come by for a number of reasons. Firstly, there's a very short growing season in the subarctic (e.g. at Kevo daily mean temperature is above +5 approximately for 110 days in a year) (<http://ilmatiiteenlaitos.fi/terminen-kasvukausi>) and biogenic VOC emission levels are highest in early July (Faubert et al. 2010) when the early season defoliators complete their feeding period (Mäntylä et al. 2008). This leaves minimal window for field campaigns; tree leaves become fully expanded in late June and by August there can onset of senescing due to occasional night frost. The area of sampling is also protected, this means that the risk to damage of vegetation and fauna has to be kept at a minimum. Unfortunately, other field campaigns have taken our time in other summers and we haven't been able to go back to Kevo for further sampling.

Reviewer Comment 2: The limited data set at one time point lead to almost no statistical conclusions, showing AS in mountain birch induced by rhododendron VOCs (hypothesis c). The presence of a low number of insects (no data given) during the experimental period is a typical variable in field conditions, making it obligate to repeat the experiment several times to generate a sample set suitable for a comprehensive

C2

statistical analysis.

Author's Response: Thank you for raising the issues as to lack of insect data. We regret not including it in this version of the manuscript. We agree that though herbivory was generally low, mite density was quite frequent especially in trees with RT in the understory. In all, 3830 leaves were examined from the 24 MB trees, 868 had gall mites infestation and other insects were found occasionally. In the revised version, the focus of our herbivory report will be only on the gall mites infestation and we will exclude total arthropod data from the revised version. We are of the opinion that the high significant values (Table 3) to an extent makes it worth mentioning herbivory by gall mites. More datasets will definitely have made this observation more conclusive, however for reasons mentioned above this was out of our control.

Reviewer Comment 3: The limitation in sample size also weakened the testing of hypothesis b: that high temperatures reduced the re-emission (recovery) of rhododendron VOCs from mountain birch leaf surfaces. I'm very sceptical about the correlation analysis shown in Figure 2. It's not a surprise that you get highly significant correlation coefficients when ca. half of the data set (Fig. 2a, b) show zero values. Again more data points from repeated samplings would likely give more reliable results.

Author's Response: Yes, you are right that there were quite a number of points with zero values especially with ledol and aromadendrene, which were generally re-emitted in lower amounts and sometimes not at all. This could be due to a number of reasons, ledol and aromadendrene are emitted in relatively smaller rates from RT and therefore there is generally less of this compounds available for adsorption and reemission especially when compared to more prominent compounds like palustrol and myrcene. Aromadendrene also has a shorter atmospheric lifetime compared to palustrol and could have been oxidized in the atmosphere before adsorbing on surrounding foliage. We however have a good number of values for the other more prominent compounds like palustrol (Fig 2c) and Total Adhered Emissions (which includes myrcene) figure 2d.

C3

Reviewer Comment 4: Scientifically I'm wondering how this negative correlation can be obtained: the y-axis in Fig 2 shows normalized (to 30°C) emission rates correlated to measured air temperature (below 22°C). Why haven't the emission rates of rhododendron VOCs from birch not been shown under ambient temperature conditions?

Author's Response: In figure 2, we show the non-standardized emission rates on the y-axis and sampling temperature on the x-axis. For emission of Rt volatiles from MB surfaces we did not consider standardization of temperature to 30°C (this information will be added in the figure caption) due to fact that these compounds are released not in the same way as volatile compounds produced by birch. Non-photosynthesising tissues like bark surfaces can also serve as points of adsorption and rerelease of these adhered compounds.

Reviewer Comment 5: Re-emission of VOCs from an adsorbed pool in the surface of a neighbouring plants requires in a first step the adsorption. No information is given on this process (rather than discussed). Higher temperatures most likely cause a stronger VOC emission from rhododendron, while lower temp. might favour the deposition of these VOCs in leaf surfaces. Theoretically, there should be a temperature-dependent equilibrium between deposition and re-evaporation of VOCs on plant surfaces. How does this looks like? Without such an information the data in Figure 2 cannot be interpreted.

Author's Response: We agree that theoretically there should be a temperature-dependent equilibrium point between adsorption and re-emission, unfortunately we cannot show this here and were hesitant to speculate about it in the manuscript. Furthermore, we do not know yet enough the temperature-dependent behaviour of adhered compounds in lower canopy which is exposed e.g. to sunflecks leading to variable temperature history of leaves between branches in the same tree. Therefore, controlled lab experiments have to be conducted to parametrize equilibrium points at different temperatures for different compounds. What we show in our work is that sampling temperature influenced recovery of the adhered compounds, and even monoterpenes

C4

(myrcene) with high vapour pressure can be recovered from birch foliage in subarctic conditions, if there is a high density of myrcene-emitting plants in understory. The exact mechanism of how temperature affects the emission, deposition or re-emission of these compounds individually and as a bouquet is beyond the scope of this study.

Reviewer Comment 6: Does absence of re-evaporation of VOCs from birch leaves at .temperature above ca. 13°C means that all compounds were already released before the sampling period started? Author's Response: We agree that reviewer might be right here. We will add more information about the prevailing conditions during and before sampling. As detailed in the response to the next comment 7.

Reviewer Comment 7: Since the samples were collected over 3 days it might be possible that the temperature differences during adsorption of the compounds influenced the later re-evaporation. No information is given on previous temperature and also time of the day of sampling which might have influenced the release. Overall, I think the present work shows preliminary data on a very interesting scientific topic.

Author's Response: The reviewer raises important points here. Limiting VOC sampling only to two-day period was aimed to reduce variation originating from changing weather conditions. It is true that temperature possibly influences the adsorption and rerelease of these compounds. Ambient temperature data preceding and during the whole sampling campaign will be given in the revised version. However, this excludes real temperature history of sampled branches. Short term sun flecks in the lower canopy branches may cause rapid temporary increase of the leaf up to +10 C in and stimulate emissions of volatiles (Way & Pearcy 2012). During our sampling campaign sunny periods were very short, but could have been one factor leading to rapid re-evaporation of adhered compounds from bark and leaf surfaces already before our VOC collection resulting in variation between samples. Time of day for sampling was randomized to reduce the effect of daily temperature variation on volatile rerelease.

Specific comments:

C5

Figures: the quality of the Figs 1,2 should be improved: the legends are too small to read, the lines are too thin to really follow.

Author's Response: Thank you for your comments, this will be improved in the revised version In Fig 1 the number of n is 24; In Fig. 2 only 18: what's the reason for that? In the paper it's stated that the number of insects was small, how numbers are given. On the other hand this information is crucial for hypothesis b). This information must be given.

Author's Response: Only plants with RT in the understory was included in the analysis, hence the reason for n =18, control plants were totally excluded since it is not expected that they re-release RT volatiles. The proportion of insect damage leaves was low, so that will be omitted and the focus of herbivory will be on gall mite densities.

In Table 2 the information on the number of replicates is missing. Author's Response: In table 2, n = 6 for control, 12 for moderate Rt plots and 6 for high Rt plots. This will be included in the revised manuscript.

The correlation analysis in Table 3 cannot be evaluated without showing any information of the arthropod parameters (see above).

Author's Response: We will include data on gall mites density in the revised version of the manuscript. Insect damage and arthropod densities as mentioned earlier was too occasional to be considered in the analysis – this will be excluded.

Shortening of the introduction: The introduction is very very long: It should be condensed focusing on the background of the research within the paper: e.g. 2nd last section (l. 147ff) can be omitted.

Author's Response: Thank you for your comment. We will condense and refocus the introduction.

Also the discussion is very long, in relation to the data present; it can be strengthened as well. l. 354: it must be Shown by Li & Blande (2015)

C6

Author's Response: We will shorten discussion and focus on the strong points of the dataset.

References

Faubert P, Tiiva P, Rinnan Å, Michelsen A, Holopainen JK and Rinnan R. 2010. Doubled volatile organic compound emissions from subarctic tundra under simulated climate warming. *NewPhytologist*187:199-208.

Mäntylä E., Alessio, G.A., Blande, J.D., Heijari, J., Holopainen, J.K., Laaksonen, T., Piirtola, P. & Klemola T. 2008. From plants to birds: Higher avian predation rates in trees responding to insect herbivory. *PLoS ONE* 3(7): e2832. doi:10.1371/journal.pone.0002832.

Way DA, Pearcy RW 2012. Sunflecks in trees and forests: from photosynthetic physiology to global change biology. *Tree physiology*, 32: 1066-108

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-464, 2016.