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Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐ A description of all covariates tested
☐	☒ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐ Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	No software was used.
Data analysis	Raw data obtained from proton transfer reaction-time of flight-mass spectrometry (PTR-TOF-MS) were analysed by the PTRwid program. Data obtained by gas chromatography-mass spectrometry (GC-MS) were analysed by the PARADISe program (version 1.1.8). Statistical analyses were performed using R (version 3.4.1). Relevant references are provided in the Method Section.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

All data that support the findings of this study are available on the Supplementary Information and in Figshare with the data DOI identifier: 10.6084/m9.figshare.7879340.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	The study employs long-term in situ warming to assess the impacts of warming and insect herbivory on plant volatile organic compound emissions from the widespread circumpolar dwarf birch (Betula nana), a major player in ongoing Arctic greening. The experiment comprises open top chambers in place during summer on an arctic tundra heath in northern Sweden for 8 and 18 years in a randomized complete block design. The study involves three independent experiments. The first experiment describes the impacts of experimental warming and mimicked insect herbivory (exogenous application of methyl jasmonate) on Betula nana volatile emissions (n=18). The second experiment describes the temporal dynamics of volatile emissions from Betula nana upon either real insect herbivory (autumnal moth, Epirrita autumnata) or mimicked insect herbivory (n=4). The third experiment describes the effects of experimental warming on insect herbivory pressure on Betula nana (n=18).
Research sample	Dwarf birch, Betula nana, growing in an arctic tundra ecosystem in northern Sweden (68°21'N, 18°49'E, elevation 385 m above sea level).
Sampling strategy	Sample size calculations were not performed since the study takes advantage of the already existing long-term manipulation experiments simulating climate change-induced summer warming and increased leaf litter fall. The long-term warming experiment (18 years prior to the study) started in 1999 and comprises 24 plots (1.2 m x 1.2 m) equally distributed in six blocks, with the four plots within each block randomly assigned to control, warming, litter addition and their combination. The medium-term warming experiment (8 years prior to the study) started in 2009 and consists of six warming plots (1.2 m x 1.2 m) equally distributed in the existing six blocks, with six control plots established in 2017. In the beginning of the study, two Betula nana plants with no visible damage by naturally occurring insect herbivores or diseases were selected in each plot and were randomly assigned to either mimicked insect herbivory treatment or control. Therefore, the herbivory treatment is nested in the warming treatment.
Data collection	Data collection was described in detail in the Method section. For the experiment assessing in situ warming effects on volatile emissions, volatile samples were collected into adsorbent cartridges from enclosed Betula nana branches and analysed by gas chromatography-mass spectrometry (GC-MS) following thermal desorption. For the experiment investigating temporal dynamics of volatile emissions, volatile emissions from detached Betula nana shoots was continuously monitored by using high-resolution proton-transfer-reaction time-of-flight mass spectrometry (PTR-ToF-MS). For the experiment assessing warming effects on insect herbivory pressure, Betula nana foliage damage caused by natural herbivorous insects was visually inspected. Data collection was performed by Tao Li.
Timing and spatial scale	The data collection lasted from July 12 to September 1, 2017, covering the short growing season. In situ volatile collection from Betula nana plants growing in the experimental plots was conducted twice (July 17–24 and August 23–30, respectively). The experiment measuring real-time volatile emission dynamics was performed in a temporal shelter under semi-natural condition (i.e., constant light, varying temperature and relative humidity) during July 13–21 (with a focus on the response to real insect herbivory) and August 23–September 1 (with a focus on the response to mimicked insect herbivory). The development of larval development determines, when insect herbivory effects can be assessed, and performing the real-time measurements simultaneously also using mimicked herbivory was not feasible. Foliage damage survey was conducted in all experimental plots on July 24 and August 28.
Data exclusions	No data were excluded.
Reproducibility	The in situ warming effect on volatile emissions was investigated in both July and August, for which the findings were consistent. Measurements on volatile emission dynamics in response to either real or mimicked insect herbivory were repeated four times, with consistent results observed.
Randomization	Warming manipulation was randomly assigned to experimental plots in each block. Mimicked herbivory treatment was randomly assigned within each experimental plot.
Blinding	Blinding is not relevant to the study because volatile collection was conducted almost simultaneously from all treatments and because all volatile data were processed under the same criteria.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	The study took place in a wet arctic tundra heath located in Abisko, northern Sweden (68°21'N, 18°49'E, elevation 385 m above sea level). Mean annual temperature is around 0.2°C (1986–2015 average), with July and February being the warmest (11.9°C) and coldest (-10.0°C) months, respectively. Mean annual precipitation is 370 mm (1986–2015 average). Snowmelt occurs from late April to mid-May, and the snow-free period typically lasts from late May to early October. From early June to mid-July, daylight persists for 24 hours.

Location	Abisko, northern Sweden (68°21'N, 18°49'E, elevation 385 m above sea level).
Access and import/export	The access was applied for and admitted by the Swedish Polar Research Secretariat to conduct fieldwork at the Abisko Scientific Research Station (Sweden), which provided accommodation and logistics support.
Disturbance	No significant disturbance was caused by the study, as the experiment was already existing, sampling was mainly air sampling, and as the insect species used therein was native to and captured in the study region.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☐	☒ Animals and other organisms
☒	☐ Human research participants
☒	☐ Clinical data

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals	The study did not involve laboratory animals.
Wild animals	The study did not involve wild animals, and it only used the herbivorous insect, autumnal moth (Epirrita autumnata), which is a principal forest pest in the boreal birch forest. The larvae were captured in the mountain birch forest in the vicinity of the field experimental site.
Field-collected samples	The study did not involve samples collected from the field.
Ethics oversight	No ethical approval or guidance was required because the insect pests were collected in their native habitat and used there.

Note that full information on the approval of the study protocol must also be provided in the manuscript.