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Emission of biogenic VOCs from evergreen broadleaf tree: variation in composition of monoterpenes

Sou Matsunaga[1*], TAKAGI, Masahiro[2], KUSUMOTO, Dai[3], HIURA, Tsutom[1]

[1]Tomakomai Research Station, Hokkaido University, [2]Faculty of Agriculture, University of Miyazaki, [3]The University of Tokyo Tanashi Forest, the University of Tokyo

Introduction

Biogenic volatile organic compound (biogenic VOC, BVOC) is known to have an important role on atmospheric chemistry in both regional and a global scale. BVOCs consist of many classes of organic compounds such as isoprene (C_5H_8), monoterpenes (MNTs: $C_{10}H_{16}$) and others. Although emission pattern of isoprene, which has the largest emission rate, is relatively well modeled as a result of many efforts, that of monoterpene is still uncertain and seems to be much more complicated compares to isoprene. There should be a consistent reason for plants to synthesize and emit BVOCs because the emission of BVOCs requires considerable cost. However, there has not been any unified understanding on the factor controls BVOC emission, yet. To solve this mystery, emission of MNTs under ”natural” environment should be one of the hopeful objects because MNTs are known to have variable effect to survive in the environment (e.g. avoidance of herbivory) and because MNTs consist of numerous isomers, it implies the MNT emissions may contain higher information than other single BVOC such as isoprene. MNTs are, in general, known to be emitted from coniferous trees. Some of evergreen broadleaf (EB) trees also emit MNTs. However, report about MNT emission from the EB tree is still quite limited. Only a few EB species emit the BVOCs while other EB species emits no BVOCs even they live in the same community. Although they are living in similar environmental condition, BVOC emission of the EB trees quite differ each other. We hypothesized that there might be a clue to reveal the fundamental principle which determines and controls the BVOC emission. In this presentation, we report a preliminary result of BVOC measurement targeted on the dominant EB trees in Japan.

Experiment

Screening samples were collected for seven EB tree species using a blanch enclosure at the university of Tokyo Tanashi Forest in July 2012. The intensive sample collection has been conducted in Tano Forest Science Station of Miyazaki University (31^{o}51’8”N 131^{o}18’23”E) from 25th through 28th September 2012. The BVOC samples were collected from twenty *Castanopsis sieboldii* leaves into a glass tube filled with adsorbents using a leaf cuvette on the top of 15 m canopy tower in EB tree community. The samples were analyzed employing a gas chromatograph (GC-FID) coupled with a cryo-focus and thermal desorption system.

Result and discussion

As a result of the screening, only *Castanopsis sieboldii* was found to be MNT emitter among investigated EB trees. The MNT emission rates ranged from 0.04 - 30 (alfa-pinene) micro gC g^{-1} h^{-1}. The averaged total MNT emission rate was 19 micro gC g^{-1} h^{-1}, it is comparable to or exceeds that of *Pinus* trees which is commonly known as major MNT emitter. Light dependence on the emission was not clearly observed. The emission rates were normalized to obtain basal emission rate, which can be regarded as ”emission activity”, based on G93 temperature dependence model with empirical coefficient *beta* of 0.10. Figure 1 shows composition of MNT basal emission rates. A clear contrast of the composition among the individuals can be observed while total emission rates were relatively close each other. Individual 1 emitted sabinene as the most abundant MNT while ocimene was one of minor MNTs. On the contrast, individual 2 and 3 emitted ocimene as 2nd or 3rd most abundant MNT while sabinene was minor MNT. Although these individuals are same tree species and are almost same ages, in addition, growing in quite similar environment (within only 1-2 m of distance each other), the composition of the MNTs showed a clear difference. It can be hypothesized that the *C. sieboldii* trees emitted different types of MNTs as responses to stresses they are exposed to. In other words, spatial distribution of BVOC emitting / non-emitting trees and/or the distribution of BVOC types in the community probably contain a clue to the mystery of fundamental factor of the BVOC emissions.

Keywords: Biogenic Volatile Organic Compound, Atmospheric Chemistry, Biosphere Atmosphere Interaction, Biogeoscience, Material Cycle, Evergreen Broadleaf Tree

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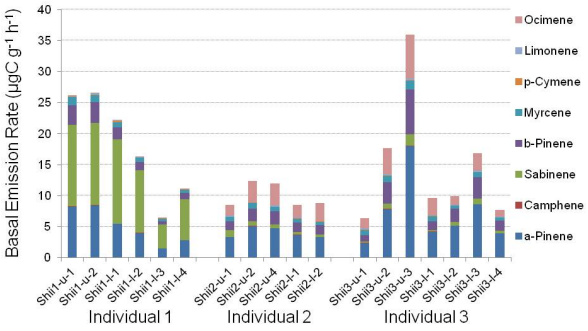

Figure 1 Basal emission rates of monoterpenes emitted from *Castanopsis sieboldii* trees obtained by leaf level BVOC measurement.