

## **Linking Ecosystem Ecology to Insect Population Ecology: Nitrogen Cycling, Foliage Properties, and Insect Outbreaks**

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**Abstract** The beech caterpillar, *Syntypistis punctatella* (Motschulsky) (Lepidoptera: Notodontidae), often causes extensive defoliation of beech forests in Japan. Outbreaks often occur synchronously among different areas at intervals of 8 – 11 years. Defoliation by this insect tends to occur at a specific range of elevations. This range of elevation varies among regions, but the outbreak zone tends to be lower at higher latitudes; e.g. 300–500 m ASL in southern Hokkaido (42°N), 600–800 m ASL in Hakkohda (40°40'N), 900–1100 m ASL in Hachimantai (40°N), and 1100–1300 m ASL in Hakusan (36°N). As a result, defoliated areas spread horizontally in altitudinal belts. Many hypotheses have been presented to explain elevation-dependent population outbreaks. In Hachimantai, five study plots were established along elevational gradients running through each plot. In each plot, beech saplings (3–5 m at height) were manually defoliated to investigate foliage quality and delayed induced response after insect defoliation. Soil nitrogen availability was determined by measuring  $\text{NH}_4^+$  and  $\text{NO}_3^-$  concentration in soil extracts. Soil nitrogen availability and foliage quality was highest in the plot where the beech caterpillar reached outbreak levels. A positive feedback among soil nitrogen availability, foliage quality, and insect population increase were identified in the system. We hypothesized that the rate of nitrogen cycling relative to altitude is key to determining these three factors.