Impacts of Deer Overbrowsing on Aquatic Insect Fauna in Headwaters

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Introduction

Browsing damage by sika deer (*Cervus nippon*) has become serious problems in forests in late years.

(Akashi & Nakashizuka, 1999; Suzuki et al., 2008)

Regression of forest understory vegetation by deer browsing.

(Nomiya et al., 2003; Tamura, 2008; Suzuki et al. 2008)

Alteration of forest soil physical properties.

(Furusawa et al., 2003; Yanagi et al., 2008)

Activization of soil surface erosion.

(Wakahara et al., 2008; Tsuneda, 2006)

We investigated how deer existence affect insects which take basic parts of river ecosystems by comparison among three small catchments.

Can these changes induce
- Increase of sediment runoff into streams?
- and any impacts on river ecosystems?
Study site: Ashiu Research Forest, Kyoto, Japan

Deer population density has been excessive for last decade, and regression of understory vegetation is emerging in this area.

- Altitude: 635～800m
- Annual Average Precipitation: 2,298mm (1976-2005)
- Annual Average Temperature: 11.9°C (1976-2005)

Ground is covered with heavy snow from mid-December to early April.

Geological Condition: Sandstone and mudstone or shale of Tanba Belt belongs to Paleozoic and Mesozoic era.

Soil: Almost Brown forest soil.

First order streams in this forest were selected as investigation sites.
Candidate catchments

- **Fenced catchment (1.15ha)**
- **Unfenced catchment (1.66ha)**
- **Plantation catchment (1.31ha)**
## Descriptions of each catchment

<table>
<thead>
<tr>
<th>Fenced catchment (1.15ha)</th>
<th>Unfenced catchment (1.66ha)</th>
<th>Plantation catchment (1.31ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural mixed forest</td>
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<td>Cedar plantation (74-year-old)</td>
</tr>
<tr>
<td>• Deer invasion is impossible.</td>
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</tr>
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<td>• Composed of mainly Cryptomeria japonica partly scattered Quercus crispula, Acer crataegifolium, Styrax obassia.</td>
</tr>
</tbody>
</table>
• In Fenced catchment, high vegetation cover density was observed.
• In Unfenced catchment, lower hillslope wasn’t covered with abundant understory vegetation, and partly exposed soil surface were confirmed.
• In Plantation catchment, understory vegetation were hardly distributed. Instead, very abundant cedar litter covered the whole of the catchment.
Stream bed environmental characteristics of each catchment

Relative solar radiation in the stream of Plantation catchment was significantly smaller than other catchments.

However, average of total quantity of chlorophyll in the stream of Unfenced catchment was the smallest.

Frequent sediment runoff might be induced in Unfenced catchment and causes larger proportion of deposited fine sediment in stream bed than that of streams of other catchments.

a, b, c : Same alphabets indicate significant difference each other at 5% level (One-way ANOVA and Tukey’s HSD test).
Methods

Collections of benthic animals

Four quadrats were set by 25cm*25cm, 0.5mm sieve mesh surber net in streams of each catchment.

Collections of aquatic insect

Identification
Evaluation methods of aquatic insect fauna

1. Comparisons of number of individuals and taxa

2. Comparison of Simpson’s diversity index

3. Life types ※1

※1
- **Swimmer**: Main mean of transportation is swimming
- **Crawler**: Move around stream bed on their legs
- **Clinger**: Cling to others by their adhesive apparatus or crotchets
- **Burrower**: Live with burrowing into sediments

4. Functional feeding groups ※2

※2
- **Shredder**: Nibble litter
- **Collector-gatherer**: Collect deposited FPOM and feed it
- **Filterer**: Feed suspended organic matters after filtering by their hair
- **Predator**: Prey other animals
- **Grazer**: Reap periphyton and feed it
Two-way ANOVA and Tukey’s HSD test indicated no significant differences of number of individuals and taxa between months and catchments.
Aquatic insect diversity of the stream of Fenced catchment was the highest among three catchments except for in May.
・Proportions of Burrowers in the stream of Unfenced catchment were significantly larger than those of other catchments.

・Those of Clingers in the stream of Unfenced catchment were significantly larger than those of other catchments.

(Chi-square test and residual analysis) *: Significantly larger than other sites ($p<0.05$).
◆: Significantly smaller than other sites ($p<0.05$).
Proportions of Shredders in the stream of Plantation catchment were significantly larger than those of other catchments.

Japanese cedar plantation provides abundant litter as an important feeding resource for aquatic insects.
Conclusions

- **Diversity**

  Exclusion of deer invasion contributes an improvement of aquatic insect diversity or microhabitats for them in the stream of **Fenced catchment**.

- **Life types**

  - Burrower
  - Clinger
  - Shredder

- **Functional feeding groups**

  - Deposited fine sediment
  - Abundant litter

**Fenced catchment**

**Plantation catchment**

Deer overbrowsing might induce an alteration of microhabitats for specific aquatic insect groups by increasing sediment runoff.
Thank you for your attention!

Photos of Ashiu Research Forest