The Effect of Grazing on Plant Biomass Allocation in Northern Mongolian Forest Steppe

Amgaa Batbaatar\(^1\)
Bazartseren Boldgiv\(^1\)
Lkhagva Ariuntsetseg\(^1,2\)

\(^1\)Department of Ecology
School of Biology and Biotechnology
National University of Mongolia

\(^2\)Department of Botany, University of Wyoming
Herbivores and plants have coevolved. One of the interesting indicators of this relationship is plant biomass partition (Above-ground biomass, Below-ground biomass, and root:shoot ratio).

Strategy of most plants is determined by disturbance and resource availability.
The livestock number in two valleys (sheep unit). Data was obtained from Bayasgalan’s annual report of Hovsgol project in 2004. The names of valleys are abbreviated: DLB-Dalbay; TRG-Turag.
Weather

- The annual air temperature is -4.5°C (the coldest -21°C and warmest 12°C)
- The annual precipitation is 265 mm (falls in summer)

The climadiagram of Hatgal suom, Hovsgol province. Date were obtained from [www.weatherbase.com](http://www.weatherbase.com). Broken line is precipitation (years on record 31), solid line is temperature (years on record 36).
Description of site and vegetation

Dominant plant species in valleys

- **In Dalbay valley**
  - **Sedge:** Carex pediformis
  - **Grasses:**
    - Festuca lenensis
    - Koeleria macrantha
    - Agropyron cristatum
  - **Forbs:**
    - Aster alpinus
    - Potentilla spp
    - Pulsatilla multifida

- **In Turag valley**
  - **Sedge:** Carex duriuscula
  - **Grasses:**
    - Festuca lenensis
    - Koeleria macrantha
    - Agropyron cristatum
  - **Forbs:**
    - Aster alpinus
    - Potentilla spp
    - Arenaria capillaris


To determine how grazing intensity affects plant biomass partitioning?

To test whether the effect of grazing is different between upper slope and lower slope
The experimental design and selected plant species:
Symbols are represented a different plant species;
●. Carex duriuscula; ▲. Aster alpinus; ♦. Stipa krylovii
■. Arenaria capillaris; ♣. Koeleria macrantha;

<table>
<thead>
<tr>
<th>South facing slope of Dalbay valley</th>
<th>South upper</th>
<th>South lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalbay (less grazing)</td>
<td>one-way ANOVA</td>
<td></td>
</tr>
<tr>
<td>Turag (more grazing)</td>
<td>one-way ANOVA</td>
<td></td>
</tr>
</tbody>
</table>
Research method and material

- Above-ground (AB) and below-ground biomass (BE) with 50 replications by soil core sampler
- Rinsing to separate soil particles from plant biomass
- Separating above and below ground biomass
- Weighing plant biomass with microbalance of high precision (.001 gr) in lab

Collecting above-ground and below-ground biomass.
Dalbay valley = DLB
Turag valley = TRG
Above-ground biomass = AB
Below-ground biomass = BE
Root:shoot ratio = Ratio
South upper slope = SU
South lower slope = SL
Result: South upper

Carex: AB and BE biomasses are higher in DLB than in TRG; AB is different, BE isn’t different

Aster: In DLB, AB is high, in TRG, BE biomass is high; No difference

Stipa: AB and BE biomasses are higher in TRG than in DLB; significantly different

Arenaria: AB and BE biomasses are higher in TRG than in DLB; significantly different

Above-ground and below-ground biomass (mean ± SE) of plants in the south upper slope. The names of the valleys are abbreviated: DLB-Dalbay; TRG-Turag;
Root: shoot ratio = below-ground/above-ground: South upper

- Biomass ratio of Carex and Stipa increased with more grazing.
- Biomass ratio of Aster and Arenaria aren’t different between two valleys.

Root: shoot ratio (mean ± SE) of plants in the south upper.
## Result: South lower

<table>
<thead>
<tr>
<th>Response variable</th>
<th>Valleys</th>
<th>Carex duriuscula Average ± SE</th>
<th>Aster alpinus Average ± SE</th>
<th>Koeleria macrantha Average ± SE</th>
<th>Arenaria capillaris Average ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above-ground biomass</td>
<td>Dalbay</td>
<td>0.027 ± 0.002&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.235 ± 0.011&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.250 ± 0.010&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.271 ± 0.022&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Turag</td>
<td>0.013 ± 0.002&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.257 ± 0.011&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.209 ± 0.010&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.297 ± 0.022&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Below-ground biomass</td>
<td>Dalbay</td>
<td>0.268 ± 0.007&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.289 ± 0.022&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.213 ± 0.011&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.626 ± 0.041&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Turag</td>
<td>0.202 ± 0.007&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.333 ± 0.022&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.258 ± 0.011&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.601 ± 0.041&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Root:shoot ratio</td>
<td>Dalbay</td>
<td>13.49 ± 1.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.286 ± 0.092&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.907 ± 0.065&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.821 ± 0.250&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Turag</td>
<td>20.51 ± 1.53&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.401 ± 0.092&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.339 ± 0.065&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.331 ± 0.250&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Above-ground biomass, below-ground biomass and root:shoot ratio (mean ± SE) of plants in the south lower slope. Values with same letters and black are not significantly different at p < 0.05.
**SU vs SL: Dalbay**

**Carex:** AB is higher in SU; BE and ratio are higher in SL
**no difference**
BE and ratio are **significantly different**

**Aster:** All biomass are higher in SU than in SL
**no difference**

**Arenaria:** AB is higher in SU; BE and ratio are higher in SL
AB, BE and ratio are **significantly different**

*Comparison of biomasses (mean ± SE) between south upper slope and south lower slope in Dalbay.*
**SU vs SL: Turag**

**Carex:** AB and BE are higher in SU;  
Ratio is higher in SL  
AB and ratio are **significantly different**  
BE is **no difference**

**Aster:** AB is higher in SL;  
BE and ratio are higher in SU  
All biomass are **not different**

**Arenaria:** AB and BE are higher in SU;  
Ratio is higher in SL  
AB and ratio are **significantly different**  
BE is **not different**

Comparison of biomasses (mean ± SE) between south upper slope and south lower slope in Turag.
The grazing is affected on plant biomass allocation in northern Mongolian forest-steppe:

- Root biomass of plants increased with increasing grazing intensity
- Root:shoot ratio of plants increased in the more grazed valley

Similar to our result: van der Maarel and Titlyanova (1989);
In contrast: Zhao et al. (2005)

- These plants have different response for grazing by their root system
  (tap root or fibrous root)

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The effect of grazing is not different between south upper and south lower in Dalbay valley.

There are differences in plant response to grazing between south upper slope and south lower slope in Turag.
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Thank you for your attention