Effects of dwarf bamboo on soil

土壌に対するササの影響

（soil temperature, soil nitrogen, fine root, soil water）

2012.10.19 Luncheon seminar

What is dwarf bamboo?

- 主にイネ科タケ亜科ササ属・スズタケ属に属する
- 分布は日本及びその周辺
- 北海道にはクマイザサ・チシマザサ・ミヤコザサ・スズタケが生育
- 60数年周期で更新？

Effects of dwarf bamboo

- Limit the light environment of the forest floors
  （光環境の制限）
- Litter decomposition is difficult
  （リターの難分解性→養分不足・病気の発生）
- Hideout small animal （小動物を天敵から隠す）
  →feeding damage & incidence of a disease
  （食害などの発生）
- 調査の邪魔！ etc…

Effects on seedling and upper trees

- Effects on seedling

  →limit the light environment

  （LAI 5.0, 相対照度1%）

  →Inhibition regeneration

  （更新阻害）
- Effects on upper trees

  →???

New knowledge

- Effects on soil temperature
  （地温への影響）
- Effects on soil nutrient & fine roots
  （養分・細根への影響）
- Effects on soil water
  （土壌水分への影響→上層木への影響）
  →effects on upper tree

references

- Takahashi K. et al (2002)Effect of understory dwarf bamboo on seasonal changes in soil temperature in a *Betula ermanii* forest, northern Japan. Eurasian J. For. Res 5: 49-53
- Takahashi K. et al (2003)Effect of understory dwarf bamboo on soil water and the growth overstory trees in dense secondary *Betula ermanii* forest, northern Japan. Ecol. Res. 18:767-774
- Tripathi SK. et al (2006) The effects of understory dwarf bamboo (*Sasa kurilensis*) removal on soil fertility in a *Betula ermanii* forest of northern Japan. Ecol. Res. 21:315-320
- Tripathi SK. et al (2005) Growth and substrate quality of fine root and soil nitrogen availability in a young *Betula ermanii* forest of northern Japan: Effects of the removal of understory dwarf bamboo(*Sasa kurilensis*) Forest ecol. Manage. 212:278-290

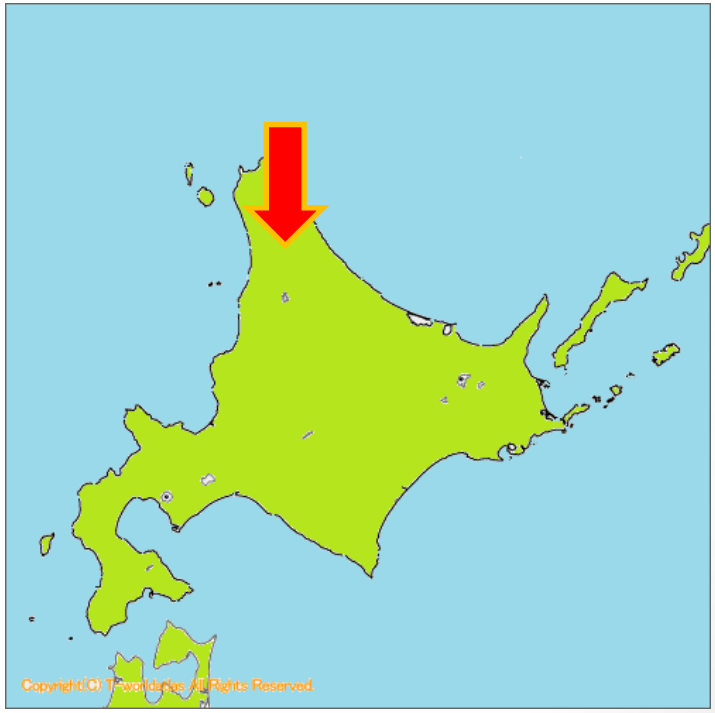
Study Site

- Uryu experimental(北大雨竜演習林)
- *Betula ermanii*(secondly forest),チシマザサ

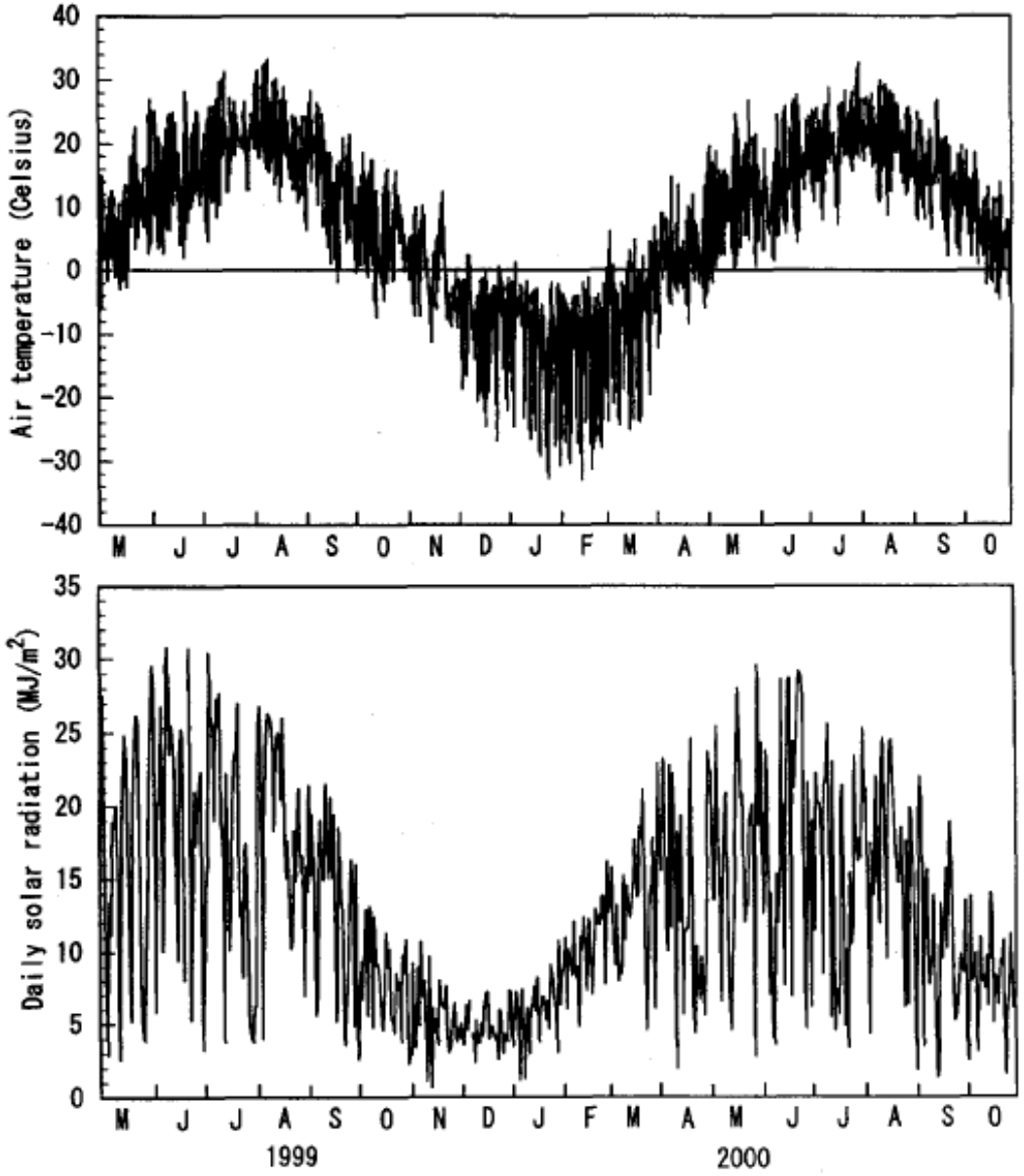
  Sasa-remove （SR）

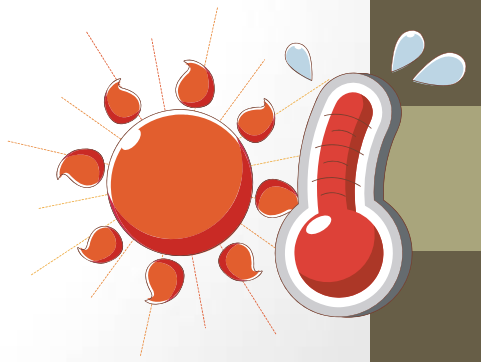
  Sasa-present （SP） に区分

(removed *Sasa* in 1998 Oct)



The seasonal changes in air-temperature & solar radiation





The changes of soil temperature in SR

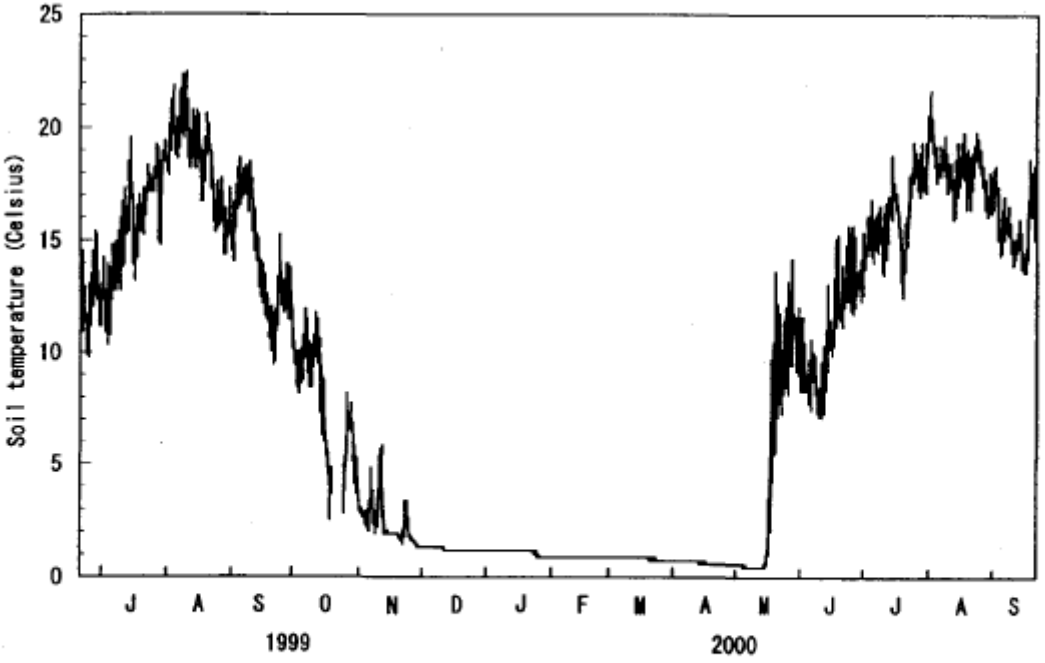
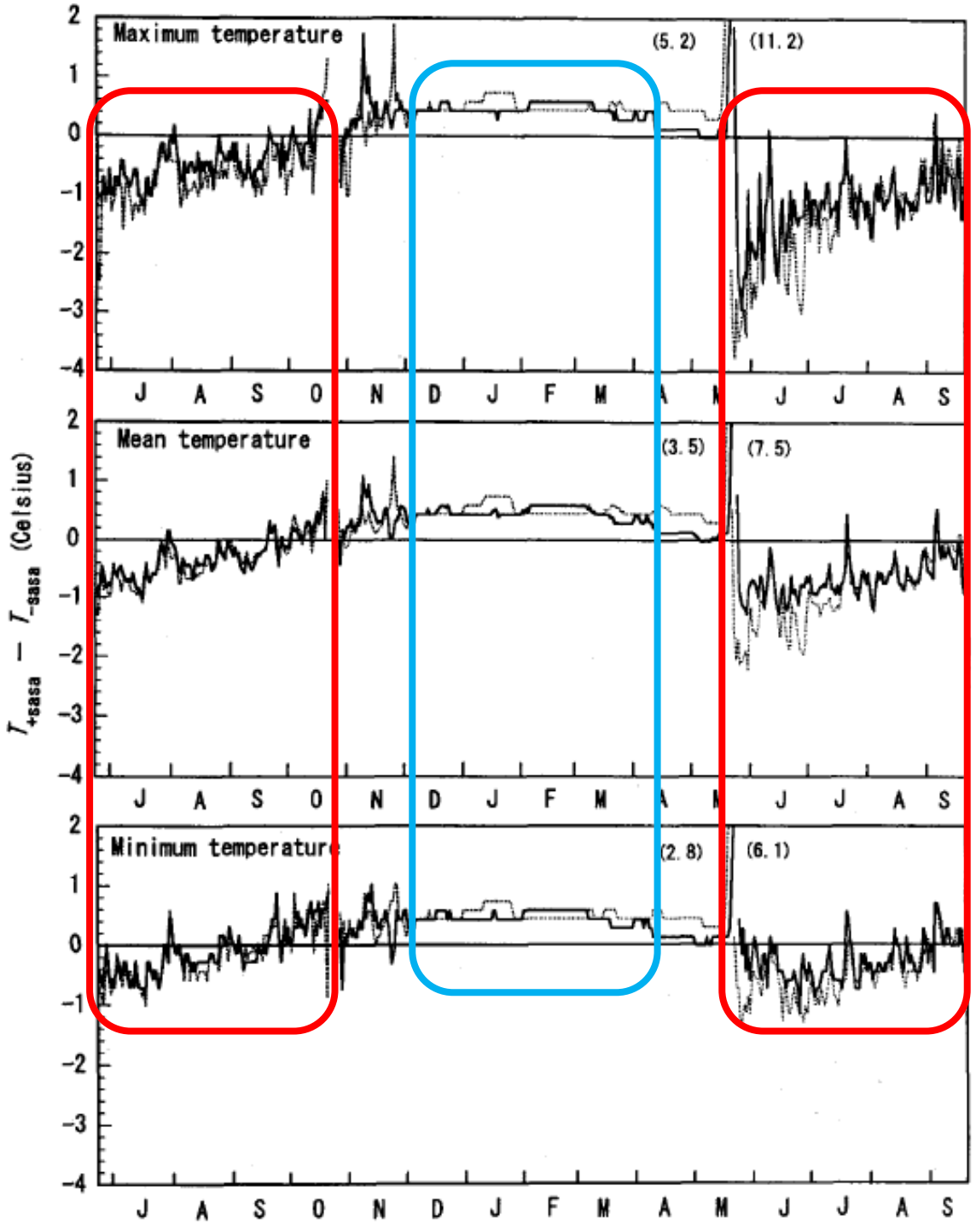


Fig. 2. The seasonal changes in the soil-temperatures at 5 cm below the surface in Plot-2a with *Sasa* in a dense secondary *Betula ermanii* forest. The daily maximum and minimum values were expressed by a vertical bar for each day.

表層から5cmの地点で測定
（99年～00年）

地温は0℃以上！



Soil temperature

SP — SR

Snow covered

→ SP > SR

not snow covered

→ SR > SP

Discussion (effect in soil temperature)

- Snow covered : SP > SR

  →presence of air in sasa-layer had an adiabatic effect

  (空気を含んだササの層が断熱効果を持つ)

- Growing season of trees

  →The solar radiation strikes the soil surface

  (土壌表面に太陽放射が届く)

  →active decomposition…?

  (リターの分解等活発に？)

Soil nutrient & fine root(method)

- after 5 years

Soil sampling(0～10、10～20、20～30cm)

※MBC・MBN・N・C・soil pH

Root sampling(0～10、10～20、20～30cm)

※15×15×30cm depth

soil nutrient（result）

Table 1
Depth-wise physico-chemical soil properties in *Sasa*-present and *Sasa*-removed stands of a young *B. ermanii* forest of Northern Japan in June 2

Soil properties	*Sasa*-present/soil depths			*Sasa*-removed/soil depths		
	0–10 cm	10–20 cm	20–30 cm	0–10 cm	10–20 cm	20–30 cm
Bulk density ($g\,cm^{-3}$)[a]	0.49 ± 0.03^{a}	0.64 ± 0.04^{ab}	0.77 ± 0.07^{b}	0.47 ± 0.05^{a}	0.47 ± 0.02^{a}	0.69 ± 0.01^{b}
Gravimetric soil water ($g\,100\,g^{-1}$)[a]	61 ± 3.2^{ab}	64 ± 2.9^{ab}	58 ± 4.5^{a}	71 ± 3.0^{ab}	69 ± 3.5^{ab}	74 ± 1.8^{b}
pH	4.4 ± 0.09	4.3 ± 0.07	4.3 ± 0.1	4.2 ± 0.07	4.2 ± 0.05	4.3 ± 0.05
Total C ($g\,100\,g^{-1}$)	9.2 ± 0.2^{cd}	7.9 ± 0.3^{bd}	6.6 ± 0.02^{ab}	10.7 ± 0.5^{c}	7.4 ± 0.34^{b}	5.7 ± 0.4^{a}
Total N ($g\,100\,g^{-1}$)	0.86 ± 0.03^{c}	0.77 ± 0.05^{bc}	0.63 ± 0.01^{ab}	1.1 ± 0.02^{d}	0.73 ± 0.02^{bc}	0.56 ± 0.04^{a}
Microbial biomass C ($mg\,kg^{-1}$)	2602 ± 263^{bc}	1908 ± 215^{b}	1095 ± 72^{a}	3117 ± 54^{c}	1718 ± 28^{ab}	790 ± 70^{a}
Microbial biomass N ($mg\,kg^{-1}$)	570 ± 62^{bc}	420 ± 56^{b}	261 ± 15^{ab}	685 ± 11^{c}	407 ± 16^{b}	226 ± 17^{a}
NH_4-N ($mg\,kg^{-1}$)	13.4 ± 1.7^{bc}	10 ± 0.3^{ab}	8.7 ± 1.1^{a}	16.3 ± 0.2^{c}	10.2 ± 0.7^{ab}	8.1 ± 0.4^{a}
NO_3-N ($mg\,kg^{-1}$)	1.5 ± 0.05^{a}	1.7 ± 0.24^{a}	1.2 ± 0.05^{a}	5.5 ± 0.5^{b}	3.9 ± 0.8^{b}	1.7 ± 0.2^{a}
Inorganic-N ($mg\,kg^{-1}$)	14.9 ± 1.7^{b}	11.8 ± 0.6^{ab}	9.9 ± 1.1^{a}	21.8 ± 0.3^{c}	14.1 ± 0.4^{ab}	9.8 ± 0.6^{a}
Nitrification ($mg\,kg^{-1}\,month^{-1}$)	2.7 ± 0.8^{a}	–	–	6.3 ± 0.2^{b}	–	–
N-mineralization ($mg\,kg^{-1}\,month^{-1}$)	16.7 ± 1.2^{a}	–	–	23.8 ± 0.6^{b}	–	–

Values are means ± S.E. ($n = 3$) and expressed on a dry soil-weight basis. F_1, F_2 and F_3 represent soil depth, *Sasa*-removal treatment and their intera
with different superscript letters denote a significant difference ($p < 0.05$; Tukey's HSD). *F*-values are indicated by superscript asterisks and ns
[a] Values are based on six replicates, estimated in July 2003.
* $p < 0.01$.
** $p < 0.05$

SR>SP

All layer: N・NO3-N

Upper layer: Nitrification・N-mineralization

Table 2

Changes in the amount of different root and rhizome (root–rh) categories to a depth of 30 cm and total live and dead root–rh ratios in *Sasa*-present and *Sasa*-removed stands of a young *B. ermanii* forest of Northern Japan in June and October

Categories	*Sasa*-present (g m^{-2})		*Sasa*-removed (g m^{-2})	
	June	October	June	October
Live				
Very fine root < 0.2 mm (VFR)	254 ± 31^{bc}	416 ± 29^{d}	331 ± 46^{cdf}	487 ± 54^{d}
Sasa fine root < 2 mm (SLFR)	208 ± 12	372 ± 68	0	0
~~*Sasa* rhizome (SLRh)~~	~~162 ± 25~~	~~116 ± 16~~	~~0~~	~~0~~
Betula fine root < 2mm (BLFR)	118 ± 10^{ab}	178 ± 16^{abf}	108 ± 13^{ab}	179 ± 14^{abc}
Betula coarse root 2–10 mm (BLCR)	104 ± 14^{ab}	146 ± 35^{ab}	214 ± 36^{bce}	119 ± 17^{ab}
Total live	846	1228	653	785
Dead				
Sasa rhizome (SDRh)	64 ± 18^{ae}	22 ± 5^{a}	237 ± 77^{bc}	157 ± 39^{ab}
Sasa fine root (SDFR)	38 ± 9^{a}	52 ± 15^{ag}	57 ± 13^{age}	26 ± 9^{a}
Betula roots (BDR)	31 ± 12^{a}	50 ± 13^{ag}	27 ± 11^{a}	58 ± 12^{ag}
Organic debris (OD)	93 ± 14^{ab}	208 ± 36^{bceg}	233 ± 53^{bc}	346 ± 39^{cd}
Total dead	226	332	554	587
All total	1072 ± 41	1560 ± 108	1236 ± 143	1373 ± 114
Total live/dead root–rh ratio	6.4	9.9	2.0	3.3

Values for June and October are the means of 2 years (2002 and 2003) ($n = 10 \pm$ S.E.). All mean values with different superscript letters denote a significant difference ($p < 0.05$; Tukey's HSD).

基本的にJun>Oct

Total live, live/Dead : SP>SR

Table 3
Distribution of root and rhizome (live and dead) mass (g m^{-2} ± S.E.) at different soil depths in *Sasa*-present and *Sasa*-removed stands in a young *B. ermanii* forest of Northern Japan

Root categories	Soil depths (cm)			
	0–10 cm	10–20 cm	20–30 cm	Total
Sasa-present (SP)				
Very fine root < 0.2 mm	155 ± 13^{ce}	105 ± 8^{bc}	75 ± 8^{bd}	335 ± 22
Sasa root < 2 mm	121 ± 12^{cd}	146 ± 36^{ce}	72 ± 11^{bd}	339 ± 46
Sasa rhizome	83 ± 17^{bde}	79 ± 16^{bde}	22 ± 6^{ab}	184 ± 25
Betula fine root < 2 mm	88 ± 12^{bdef}	52 ± 6^{abd}	27 ± 4^{ab}	167 ± 16
Betula coarse root 2–10 mm	69 ± 17^{bd}	49 ± 10^{abd}	29 ± 7^{ab}	147 ± 24
Organic debris	71 ± 14^{bd}	53 ± 6^{abd}	27 ± 6^{ab}	151 ± 23
Total	587 ± 37	484 ± 35	252 ± 15	1323 ± 57
Sasa-removed (SR)				
Very fine root < 0.2 mm	162 ± 17^{cf}	142 ± 14^{ce}	105 ± 12^{cde}	409 ± 35
Sasa root < 2 mm	18 ± 4^{ab}	17 ± 4^{ab}	10 ± 2^{ah}	45 ± 8
Sasa rhizome	108 ± 38^{cd}	57 ± 10^{abd}	42 ± 10^{abh}	207 ± 43
Betula fine root < 2 mm	87 ± 12^{bdeh}	47 ± 7^{abd}	27 ± 4^{ab}	161 ± 16
Betula coarse root 2–10 mm	75 ± 13^{bdh}	77 ± 18^{bdh}	41 ± 9^{abh}	193 ± 27
Organic debris	125 ± 15^{ce}	113 ± 17^{cdeh}	53 ± 8^{abd}	291 ± 35
Total	575 ± 55	453 ± 34	278 ± 15	1306 ± 86

Mean values are based on four sampling events over 2 years ($n = 20$). All mean values with different superscript letters denote a significant difference ($p < 0.05$; Tukey's HSD).

土壌深増で根量減少（上層20cmに80%存在）

Organic debris ： SP < SR

Fine root growth

Table 4
Fine root growth (g m^{-2} $period^{-1}$) estimated through root-free cages and ratio of very fine root to fine root biomass during the different measurement periods in *Sasa*-present and *Sasa*-removed stands of a young *B. ermanii* forest of Northern Japan ($n = 5$)

Period	Sampling interval (days)	*Sasa*-present		*Sasa*-removed	
		Root in-growth	Very fine root/fine root	Root in-growth	Very fine root/fine root
Jun 2002–Oct 2002	113	156 ± 22 (42.2)	2.2	87 ± 13 (23.5)	1.8
Jun 2002–Jun 2003	372	230 ± 10 (18.9)	1.4	147 ± 10 (12.1)	1.1
Jun 2002–Oct 2003	479	285 ± 34 (18.2)	0.4	230 ± 41 (14.6)	0.9

Values are means ± S.E. Values in parentheses show root mass accumulation in g m^{-2} $month^{-1}$.

SP > SR

Turnover

Table 5
Mean accumulation of organic matter, C and N in different root and rhizome categories in soil profiles to a depth of 30 cm and their turnover in two stands of a young *B. ermanii* forest in Northern Japan

Parameter	*Sasa*-present				*Sasa*-removed			
	0–10 cm	10–20 cm	20–30 cm	Total	0–10 cm	10–20 cm	20–30 cm	Total
Accumulation (kg ha^{-1})								
Organic matter	5870	4840	2520	13,230	5740	5430	2780	13,050
Carbon	2554	2100	1068	5722	2491	1970	1170	5631
Nitrogen	59	46	24	130	66	49	28	142
Annual production/input (kg ha^{-1})								
Organic matter	3177	3170	1969	8316	2362	961	881	4204
Carbon	1362	1400	831	3593	1019	412	372	1803
Nitrogen	34	30	18	82	27	10	9	46
Turnover rate (year^{-1})								
Organic matter	0.54	0.65	0.78	0.63	0.41	0.17	0.32	0.32
Carbon	0.53	0.67	0.78	0.63	0.41	0.21	0.32	0.32
Nitrogen	0.58	0.65	0.75	0.63	0.41	0.20	0.32	0.32

Annual production/input

turnover rate : SP > SR

Soil nutrient & fine roots(discussion)

- 土壌中のN：SR > SP
- 根量　：SP > SR (ダケカンバ根量はあまり変化なし)

→Nutrient competition with Sasa is relaxed

※turnover decreased (ササとの養分競争緩和)

→Increase the amount of N that can be used in *Betula*

（ダケカンバの使用できるN増加）

→Nutrient environment improvement

(ササ除去で養分環境改善？)

Soil water & *Betula ermanii* growth （methods）

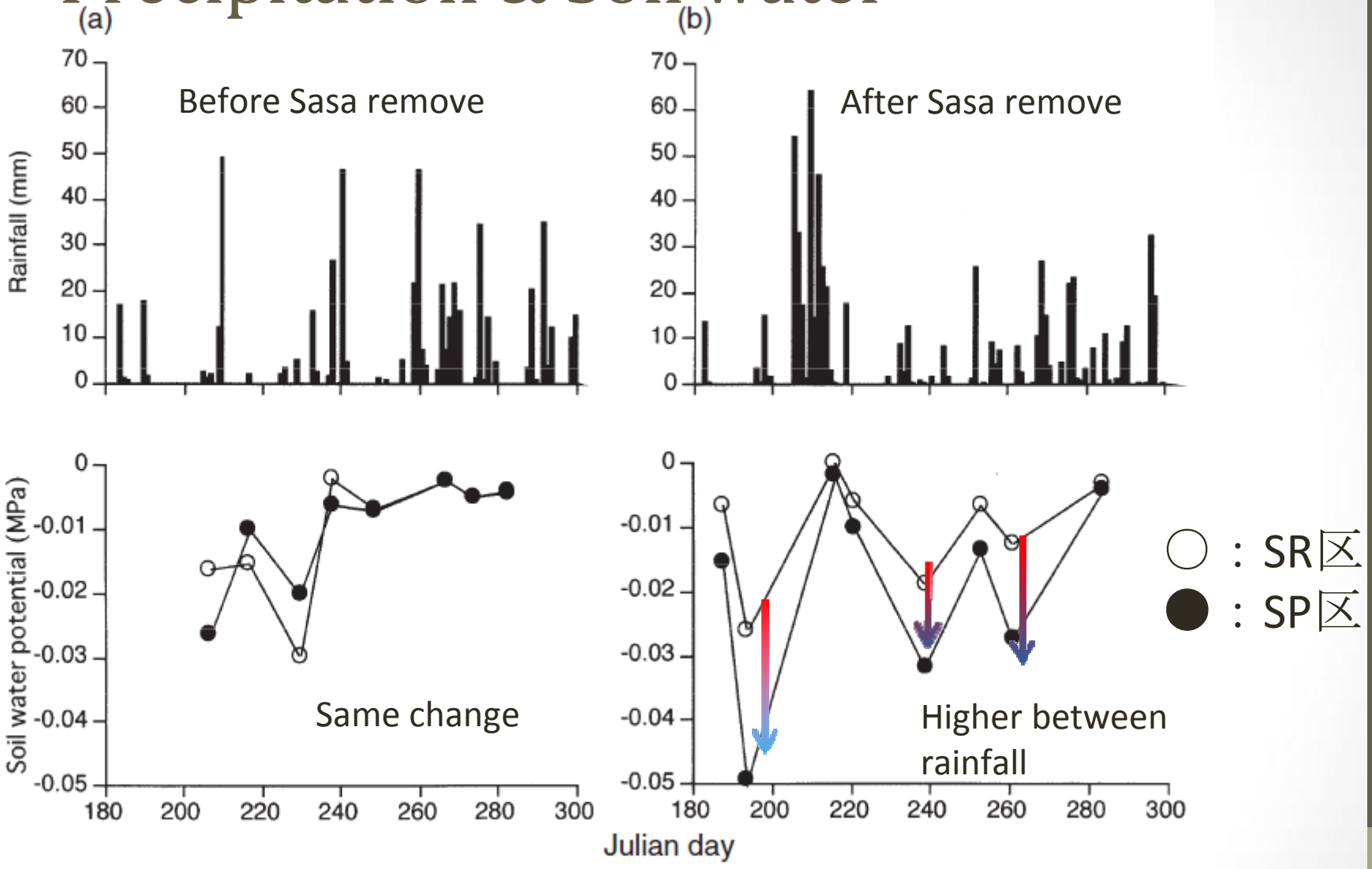
- Measure soil moisture at 25cm depth

  →from 1998～1999(July～Oct)

  precipitation
- Measure precipitation & *Betula ermanii* growth

  →成長量は98年(ササ刈前)・99年・00年に測定

Precipitation & Soil water



Discussion (soil water)

Soil water: SR > SP

→effect on transpiration of Sasa

or Rain does not reach the soil surface

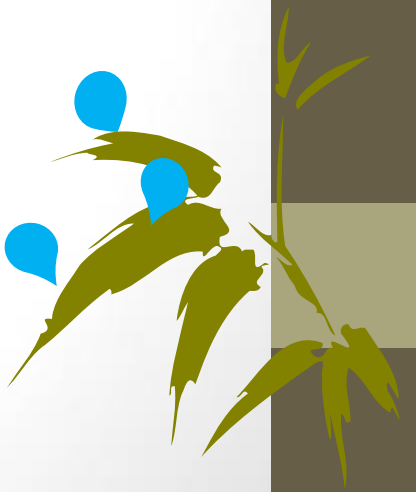
※especially happened between rainfall

(特に降水と降水の間で起こっている)

→effect on transpiration of Sasa

(e.g.下層植生の蒸散は全体の20～30%)

Rberts et al.(1980) and Kelliher and Black(1986)



Betula ermanii growth

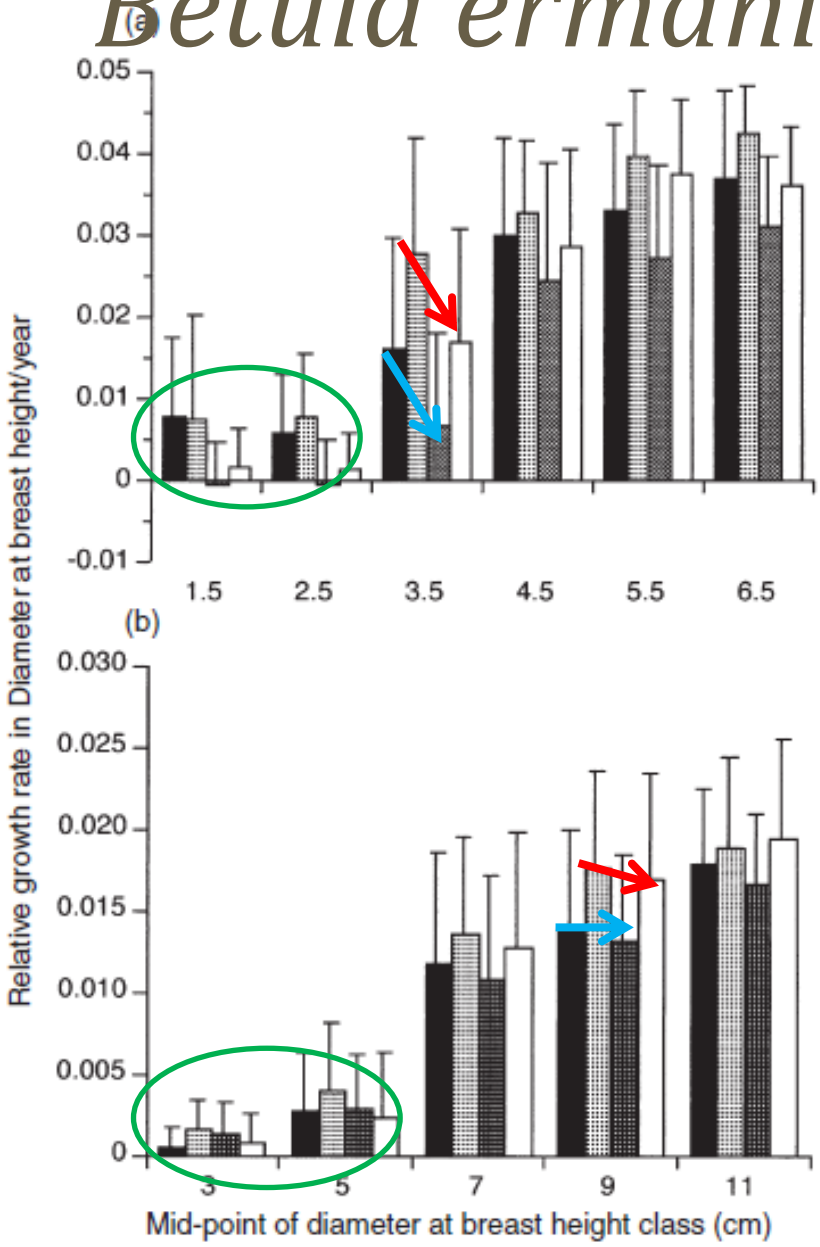


Fig. 3. Relative growth rate (with positive standard

99年　00年

■ → ▩　SP区

▨ → □　SR区

growth rate : SR > SP

→limited by Sasa transpiration

Growth of small tree is lower

(小径木の成長量小さい)

Discussion (*Betula ermanii* growth)

growth: SR > SP

→limitation of soil water (土壌水分の制限)

※stomata often close in response to the limitation of soil water availability (Oren et al.(1998)…)

→can not eat food(CO_2)…(>_<)

(気孔からCO2入らなくてご飯食べられない)

Growth of small tree is lower

→effect of big trees

まとめ

- Soil temperature

  →雪がないときに地温が上昇（土壌菌の活動活発化？）

- Soil nutrient and fine root

  →ダケカンバの利用可能なN増加

  （養分を巡る競争が緩和？）

- Soil water

  →ササによる蒸散減で水分量上昇（降水後）

  →ダケカンバの成長量減少

※水分では有意な結果が得られたが、
養分等複合的には調べられていない
→1つの調査でまとめ評価してみたら？

My conclusion

I want to cut the bamboo