

## Research Group of Forest Ecophysiology

### [Goal]

Analysis and understanding of the photosynthetic capacity of woody plants in changing environment, such as elevated CO<sub>2</sub> and increase in nitrogen deposition, in order to conserve forest ecosystem and to rehabilitate the degraded forests after the overuse by human activities.



A view of plantation of Sakhalin spruce after forest fires for four times from early 1900's at Teshio Exp. Forest, the northernmost university forest in Japan where serpentine soil is dominated. We had been planting about a half million seedlings with aid of Japan Ministry of Education, Science & Culture. However, harsh environment prevents its quick recovery in vegetation.

### [Current topics]

1. Photosynthesis and functional anatomy in relation to forest succession under the condition of global warming and soil acidification.

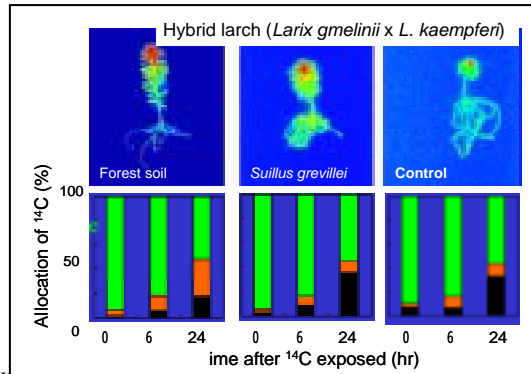


FACE experiment has been carried out with FSC staff and graduate students. We predict the change in stand structure composed of 11 deciduous tree species raised in the atmospheric CO<sub>2</sub> of 500ppm in FCAE (Free Air CO<sub>2</sub> Enrichment) with two soil types (volcanic ash vs. brown forest soil). This is the only one FCAE system for forest stands in Asia.

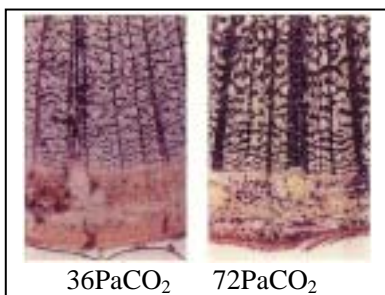
>We start the second phase of FACE experiments with the member of Prof. K. Sasa of Field Science Centre for Northern Biosphere of Hokkaido University. We are planning following topics:

- 1) Aerobic CH<sub>4</sub> efflux from tree species at elevated CO<sub>2</sub>
- 2) Nitrogen allocation of hybrid larch F1 at elevated CO<sub>2</sub> and nitrogen levels.
- 3) Regeneration activities of deciduous broadleaf trees at elevated CO<sub>2</sub> simulated to conservation of SATOYAMA
- 4) Plant defense of deciduous broadleaf trees at elevated CO<sub>2</sub>
- 5) Soil respiration characteristics after intensive disturbances.
- 6) Effect of elevated CO<sub>2</sub> on the growth of bio-fuel tree species

2. Analysis of allocation of photosynthates and growth characteristics (defense, symbiosis with ectomycorrhiza, propagation) of woody plants.



3. Wood formation as affected by global environmental changes



Xylem formation in beech (*Fagus crenata*) seedlings raised under elevated  $\text{CO}_2$  and ambient  $\text{CO}_2$ . With iodine-starch method, we can see extra-accumulation starch in xylem parenchyma of seedlings at high  $\text{CO}_2$  as compared with that at ambient  $\text{CO}_2$ .

( Kawagishi & Funada Unpublished data )

### -Research methods-

Ecophysiological analysis on the environmental stresses on the growth and development of woody species. (Photosynthesis and allocation of photosynthates)

### [Staff]

Takayoshi KOIKE

Professor of Forest Ecophysiology,

**Hokkaido University, Research Faculty of Agriculture**

(Laboratory of Silviculture and Forest Ecology Studies)

**Course in Environmental Resources, Graduate School of Agriculture,**

### -Membership-

Japanese Society of Forest Society (senator in Hokkaido Branch), Japanese Botanical Society, British Ecological Society (Member 128272), Japanese Ecological Society, Plant Species Biology, American Biological Institute, Japanese Environment Society, Japanese Atmospheric Environment, Association of Northern Forestry, Association of Forest Tree Breeding, Association of Forest Tree Breeding in Hokkaido. Society of Forest Health (senator), Japanese Society of Root Research (senator)

### -Editorial Boards-

Tree Physiology (1999, 2005-), Eurasian Journal of Forest Research (2000-), FOSNOLA (WSL: Switzerland: 2005-), Journal of Forest Research (2002-2003), Journal of Forest Health (2003-), Journal of Plant Research (1996-1999), Bulletin of Botanical Research (China:

2005-), Northern Forestry (1988-).

**Proofreading** is mainly connected with the SCITEXT in U.K. <http://www.scitext.com/>.

**-Awards-**

- Academic Award of the Japanese Forest Society in 2006,
- Academic Contribution Award to the Japanese Forest Technology Association in 2006,
- Contribution Award of International Congress on Air Pollution and Global Changes in 2004,
- Education Award for the Outstanding Chinese Students in 2004

## [Members of the group]

### -Post Doctoral Fellow-

#### >Agri-research fellow:

Dr. Yoko WATANABA (From Grad. School of Agr., Hokkaido University)

----Research topics: Wood anatomy in histochemistry for analysis on biological interactions, for identification of treasure trove in conservation of historic and artistic.

#### >JSPS research fellow:

Dr. Makoto WATANABE (From Prof. T.Izuta's Lab. of Environmental Botany at Tokyo University of Agr. & Tech.):

---- Research topics: Environmental botany of plant species as affected by O<sub>3</sub> and acid rain, Aerobic CH<sub>4</sub> emission of woody species grown in FACE (Free Air CO<sub>2</sub> Enrichment),

Dr. Satoshi KITAOKA (From Grad. School of Agr., Hokkaido University)

---- Research topics: Ecophysiology of deciduous broadleaved tree seedlings invading to unmanaged larch plantations at FFPRI (Hokkaido)

#### >FSC research fellow:

Dr. Eguchi Norikazu:

----Research topics: The effect of elevated CO<sub>2</sub> concentration on the hydraulic characteristics of representative deciduous tree species and their xylem structure with FACE.

### -Graduate Students (research topics in 2007)-

#### >at Graduate School of Agriculture

D2: Makoto KOBAYASHI (Biomass and regeneration of boreal forests under changing environment, Forest Fire Ecology)

D1: KIM YongSuk (Forest soil and analysis on the emission of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O)

M2: Shiro MATSUNAMI (Reproduction of an invasive species, Black locust with root sucker)

M2: Masaharu KANETOSHI (Photosynthetic traits of Black locust under changing environments)

M1: Kiyomi HINATA (Histochemistry of localization of defense chemicals four summer green tree seedlings under changing environment)

M1: Takayuki KARAKI (Seed ecology on an invasive species, Black locust)

M1: Koharu RYU (Photosynthesis study on larch and spruce in serpentine soil with special references to symbiosis of ectomycorrhiza)

B4: Chiho AOYAMA (Plant-insect interaction of oak and beech saplings in relation to induced defense)

B4: Masakazu IMORI (Growth analysis of larch hybrid)

B4: Yuko HASEGAWA (Forest soil)

B4: Shungo YAZAWA (Tree doctoral study in *Kalopanax* seedlings invaded in a fir plantation)

## **On going research projects:**

**Sponsored by Japan Society of Promotion of Science (JSPS)**

Carbon allocation of woody species grown in FACE and estimation of CO<sub>2</sub> efflux (2008~2011 March; Type B)

## **Past Projects related to Forest Ecophysiology under changing environment**

**>Sponsored by Ministry of Education (MEXT)**

1) FACE (Free Air CO<sub>2</sub> Enrichment) experiment for mixed broadleaved tree species. Research Revolution 2002 (partnership between nature and humanity) Prediction of ecophysiological parameters for estimating of carbon budget of the terrestrial ecosystem (2002- 2007.March)

2) Measurement of transpiration of deciduous broadleaved trees raised under elevated CO<sub>2</sub> with a FACE (2004-2006 March)

1) Prediction of forest dynamics and sustainability of mixed conifer-broadleaf forests based on a FACE study (2005-2008 March; Type A)

3) Histochemistry of plant defense chemicals in leaves at FACE (2006-2008 March)

**Sponsored by Ministry of Environment**

1) Estimation of carbon storage and growth rates of boreal forests in Russian Far East (2005-2008 March)

**Sponsored by the Sumitomo Foundation**

1) Shift in light compensation point of deciduous broad-leaved trees under elevated CO<sub>2</sub> with FACE -Examination for Oikawa's prediction-(2007-2008 October)

**>Sponsored by Ministry of Environment**

1) Ecophysiological studies on matter flow in a larch ecosystem. (S1: Study on carbon management of terrestrial ecosystem of Asia in 21<sup>st</sup> century) (2003-2007 March)

[Again: **Lectures by T.Koike**]

## **-Lectures for Master students-**

>at Graduate School of Agriculture

Forest Resources Ecology,

Topics in Global Warming by Prof. R. Hatano

Advanced Bio-signal Chemistry under conducted by Prof. Y. Hashidoko

**Past Part-time teacher:**

Tree physiology (at The Univ. of Tokyo), 1996-2005

Ecology (Forest Ecology) (at The Univ. of Tsukuba) 1998-2004

Advanced course in Forest Bio-resources (at Mie University) 1996-2003

Advanced course in Biology (at Hokkaido Univ. of Education) in 2001

## **-Lectures for Undergraduate student-**

Silviculture and Forest Ecology, Forest Protection, Forest Space and Function and its Seminar, Forest Aesthetics, Forest Ecology for Regeneration

An Introduction to Field Science (Hokkaido University),  
English training course (Forest Science)

**For overseas student:**

(HUSTEP; Short term course of overseas students in Hokkaido University),

- 1) Environmental Science of Biological Resources
- 2) An Introduction to Field Science (HUSTEP)

**Part-time teacher:**

Tree Ecophysiology (at Tokyo Univ. of Agr. & Tech.) in 2008~

Forest resources biology (at Kyoto University) in 2008

Environmental Biology (at Kyushu University) in 2007

Plant Physiological Ecology (at Tokyo Univ. of Agriculture & Technology) until 2006

Environmental Resources (at Tokyo Univ. of Agriculture & Technology) in 2007

## [Members of the group]

### >PDF or PhD course, RONPAK Dr

Dr. Tomoaki ICHIE (Associate Professor of Department of Forest Science, Kochi University;  
Tropical ecology, reproduction of woody species; Graduate School of Science, Kyoto  
University; JSPS fellow)

Dr. Ali M. QUORESHI (Researcher of Symbiotech. Alberta, Canada; Department  
of Forestry, University of Toronto, Canada; JSPS fellow)

Dr. Takami SATOMURA (From Grad. School of Integrated Arts and Science,  
Hiroshima University)----Research topics: Functional root ecology under changing  
environment

*Present address:* T. Kobayashi's Lab. (Plant Ecology), Faculty of Agriculture, Kagawa  
University, Takamatsu-City, Kagawa Prefecture, Japan

### -----OB & OG-----

Dr. Takatoshi NAKAMURA (Lecturer of Department of Plant Production Science, Tokyo  
University of Agriculture; Environmental Conservation in wetlands)

Dr. Masazumi KAYAMA (Researcher at Kyushu Research Center, Forestry & Forest  
Products Research Institute; Tree Ecophysiology in nutrient ecology, Symbiotic  
micro-organisms)

Dr. Sawako MATSUKI (Lecturer of Department of Forest Science, Iwate University;  
Plant defense of woody plants especially in Betulaceae)

Dr. QU Laiye (Associate Professor of Eco-Environmental Research Center, Chinese  
Academy of Science, Beijing: Rhizosphere physiology in forest rehabilitation with special  
references to the existence of charcoal -- ectomycorrhizal ecology. (from China)

Dr. WANG Wenjie (Associate Professor of Key Lab. of Forest Plant Ecology, Northeast  
Forestry University at Harbin, China; Production ecology, Respiration)

Dr. Mahoko NOGUCHI (Researcher at Shikoku Research Center, Forestry & Forest Products  
Research Institute; Forest ecology in vegetation science)

Dr. CHOI Dongsu (Associate Professor of Tokyo University of Agriculture & Technology;  
Soil acidification and CO<sub>2</sub> enrichment affecting growth of pine trees and symbiotic  
microorganisms in Korea and Japan. (from Korea)

- Dr. Yoshinori KITAHASHI (Researcher at Forest Products Research Institute of Hokkaido Government; Water relations in broadleaved trees in tropical regions and in shade trees in metropolis)
- Dr. Ji Donghun (c/o Prof. Yi Myonjong, School of Forest Environment, Kangwon National University, Chungchon, Korea)
- Dr. Norikazu EGUCHI (researcher at Prof. K. Sasa, FSC of Hokkaido University, FACE study in deciduous trees native to northern Japan with special references to soil fertility; wood formation)

## [Graduated students]

### >Master course

- Mrs. Yuko YANAGIHARA (Effect of soil types and vegetation changes on soil respiration in larch plantations)
- Mr. Satoshi KITAOKA (Seasonal changes of light utilization capacity in deciduous broad-leaved trees seedlings invaded into a larch plantation)
- Ms. Machiko OOISHI (Photosynthetic characteristics of spruce species grown at different soil conditions)
- Mr. Yoshinori KITAHASHI (Physiological and morphological adaptation of broad-leaved trees with two different height positions of the same sunny crown)
- Ms. Yuko SAKUMA (Anatomical structure and physiological traits of heterophyllous needles of Japanese larch (*Larix kaempferi*))
- Ms. Ikuko ENDO (Growth and survival of three species of Betulaceae seedlings in the large disturbed area.)
- Mr. Takanori SHIBATA (Plant defense in seral tree species grown under elevated CO<sub>2</sub>)
- Mr. Takeshi HIDA (Change in the light compensation point of deciduous broad-leaved tree saplings grown under elevated CO<sub>2</sub>)
- Mr. Makoto KOBAYASHI (of nitrogen supply on the growth and photosynthetic responses of seedlings of *Pinus koraiensis* grown under different light conditions)
- Ms. Yuka OTSUKA (The Localization of Defense Chemicals in Leaves of Beech and Oak)
- Ms. Noriko MORII (Water relations of deciduous broad-leaved tree saplings to elevated CO<sub>2</sub> in a Free Air CO<sub>2</sub> Enrichment(FACE))
- Mr. Kazuki Karatsu (Photosynthetic responses of birch and alder grown under elevated CO<sub>2</sub>)
- Mr. Katsukiho MATSUI (Decomposition processes in FACE system and Spruce plantation with special references to soil macro-organisms)
- Mr. Tokihisa AGARI (Plant defense in alder species under changing environment)

### > Bachelor course

- Mr. Takuma Shibutani (Nitrogen allocation in deciduous broadleaved trees)
- Mr. Tomoharu Abe (Plant defense in deciduous broadleaved trees)
- UG: Yuhki ISHII (Photosynthesis and methane emission) on leave from Tokai University in Hokkaido, Fac. Engineering. (Life science technology.)
- Ms. Sachie Naiki (Community ecology on the decomposition processes with references to leaf litter production by pruning in spruce plantation.)
- M1 Kohta KATO (Photosynthesis of deciduous broad-leaved trees grown in FACE) on leave from the Department of Bio-technology of Tokai University

## [Previous engaged staff of the group]

**Dr. Oxana MASYAGINA**

Associate Professor of Forest Ecophysiology Laboratory,  
(Doctor, Russian Academy of Science)

Engagement period: 2004 (July- Sept.), 2005 (June to Nov.).

**Specialty:** Ecophysiology of forest soil and rhizosphere environment,

On leave from V.N. Sukachev Forest Research Institute, Krasnoyarsk, Russia English

**Dr. Olga A. ZYRYANOVA**

Professor of Forest Ecology & Vegetation Science,

(Doctor, Russian Academy of Science)

Engagement period: 2004 Oct. - March, 2005

**Specialty:** Vegetation science in permafrost region

On leave from V.N. Sukachev Forest Research Institute, Krasnoyarsk, Russia

## [Publications of Koike, T.]

### -Selected articles by Koike, T.-

- (1) Koike, T. (1987) Photosynthesis and expansion in leaves of the early, mid, and late successional tree species, birch, ash and maple. *Photosynthetica* 21:503-508.
- (2) Koike, T. (1988) Leaf structure and photosynthetic performance as related to the forest succession of deciduous broad-leaved trees. *Plant Species Biol.*, 3:77-87.
- (3) Koike, T. (1990) Autumn coloring, photosynthetic performance and leaf development of deciduous broad-leaved trees in relation to forest succession. *Tree Physiol.*, 7:21-32.
- (4) Koike, T. (1995) Effects of CO<sub>2</sub> in interaction with temperature and soil fertility on the foliar phenology of alder, birch, and maple seedlings. *Can. J. Bot.*, 73 :149-157.
- (5) Koike, T., Lei, T.T., Maximov, T.C., Tabuchi, R., Takahashi, K. and Ivanov, B.I (1996) Comparison of the photosynthetic capacity of Siberian and Japanese birch seedlings grown in elevated CO<sub>2</sub> and temperature. *Tree Physiol.*, 16:381-385.
- (6) Rousi, M., Mattson, W.J., Tahvanainen, J., Koike, T., and Uotila, I. (1996) Growth and hare resistance of birches: testing defense theories. *Oikos* 77:20-30.
- (7) Koike, T., Tabuchi, R., Mori, S., Takahashi, K. and Lei, T.T. (1998) Characteristics of the light response in seedlings and saplings of two mid successional species, ash and kalopanax, during the early stage of regeneration in a mature forest. *J. Sustainable For.*, 6: 73-84
- (8) Kitao, M., Lei, T.T., Koike, T., Tobita, H. and Maruyama, Y. (2000) Susceptibility to photoinhibition of three deciduous broadleaf tree species with different successional traits raised under various light regimes. *Plant Cell Environ.*, 23: 81-89.
- (9) Koike, T., Kitao, M., Maruyama, Y., Mori, S., and Lei, T.T. (2001) Leaf morphology and photosynthetic adjustments among deciduous broad-leaved trees within the vertical canopy profile. *Tree Physiol.*, 21: 951-958.
- (10) Kayama, M., Sasa, K. and Koike, T. (2002) Needle life span, photosynthetic rate, and nutrient concentration of *Picea glehnii*, *P. jezoensis*, and *P. abies* planted on serpentine soil in northern Japan. *Tree Physiol.*, 22: 707-716.
- (11) Matsuki, S., Sano, Y. and Koike, T. (2004) Chemical and physical defense in the early and late leaves in three heterophyllous birch species native to northern Japan. *Ann Bot.*, 93: 141-147.
- (12) Kitaoka, S. and Koike, T. (2004) Invasion of broadleaf tree species into a larch plantation: Seasonal light environment, photosynthesis, and nitrogen allocation. *Physiol. Plant.*, 121: 604-611.
- (13) Koike, T., Tobita, H., Shibata, T., Mastuki, S., Konno, K., Kitao, M., Yamashita, N. and

Maruyama, Y. (2006) Defense characteristics of seral deciduous broad-leaved tree seedlings grown under differing levels of CO<sub>2</sub> and nitrogen. *Population Ecology* 48: 23-29.

### **-Chapter contributions of books (in English)-**

(1) Koike, T. (1995) Physiological ecology of the growth characteristics of Japanese mountain birch in northern Japan: a comparison with Japanese mountain white birch. *In: E.O. Box et al. eds., Vegetation Science in Forestry: Global Perspective based on Forest, Ecosystems of East & Southeast Asia., Kluwer Academic Publishers, The Netherlands, 409-422.*

(2) Reich, P.B., Koike, T, Gower, S.T. and Schoettle, A (1995) Causes and consequences of variation in conifer leaf life-span. *In: W.K. Smith and T.M. Hinkley eds., Ecophysiology of coniferous forests., Academic Press, San Diego, 225-254.*

(3) Schulze, E-D., Bazzaz, F.A., Nadelhoffer, K., Koike, T. and Takatsuki, S. (1996) Biodiversity and ecosystem function of temperate deciduous broad-leaved forests., *In: Mooney, H.A., Cushman, J.H., Medina, E., eds., SCOPE Series. Functional roles of biodiversity: A global perspective., Jone Wiley & Sons, Chichester, New York, Shingapore., 71-98.*

(4) Koike, T. (2004) Autumn coloration, carbon acquisition, and leaf senescence. *In: L.D. Nooden ed., Plant Cell Death Processes. Elsevier-Academic Press. Amsterdam, San Diego. 245-258.*

(5) Koike, T., Kitaoka, S., Ichie, T., Lei, T.T. and Kitao, M. (2004) Photosynthetic characteristics of mixed broadleaf forests from leaf to stand., *In: Shiomi, M. and Kawahata, H. eds. Global Environmental Change in the Ocean and on land. TerraPub, Tokyo, 453-472.*

### **[Cooperative research groups]**

1. Forest environment and Function group of Hokkaido University Forests
2. Forestry and Forest Products Research Institute (Hokkaido & Tsukuba)
3. Tokyo University of Agriculture and Technology (Plant Stress Physiology Lab., Wood formation regulation Lab.)
4. Center of Ecological Studies, Kyoto University (Prof. T. Ohgushi Lab.,)
5. Graduate School of Life Science, Tohoku University (Prof. T. Nakashizuka Lab.,)
6. Forest Resources Lab., Ehime University (Prof. I. Ninomiya La.)
7. National Institute of Industry (Dr. N. Saigusa)
8. Lab. of Forest Botany, Graduate School of Agriculture and Life Science, The University of Tokyo (Forest Pathology)