Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AHW28-01 Room:103 Time:May 20 09:00-09:15

Recent variation of snow as a water resource in the Japanese Alps

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The region of Japan that lies along the Sea of Japan is known to experience some of the heaviest snowfall in the world. In this region, precipitation brought by snowfall is more important as a water resource than rainfall. Recent studies have reported that the amount of snowfall in Japan will decrease as a result of global warming. However, these studies used data observed at low altitudes. The question arises whether the same theory can be applied to high-altitude mountain areas. Therefore, in this study, we discuss the relationship between temperature and the amount of snow using observation data for the Japanese Alps region and present the results of some meteorological observations we carried out at high-altitude sites in the Japanese Alps region. A relatively large part of the Japanese Alps region is within the altitude range of 1,000?3,000 m and the snowfall there serves as a vital water resource. Therefore, the effect of global warming on snow accumulation in mountain areas is a crucial issue. At places with high altitude in the Japanese Alps, it is rare for the air temperature to rise to around 0 oC at the current levels of temperature increase. An increase in winter precipitation should lead directly to an increase in snow accumulation in the high altitude area. Under the present circumstances, the role of the mountain regions as a system for purification of water and air that is essential for human beings existence is not duly recognized and is undervalued. However, there is no doubt that we need to understand the response of mountain regions to global-scale environmental change in the near future. To achieve that, we need to discuss the matter based on proper observation data. We therefore plan to continue our meteorological observations at high altitude mountain regions.

Keywords: water resource, water equivalent of snow, Japanese Alps

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AHW28-02 Room:103 Time:May 20 09:15-09:30

Winter rainfall tendency in mountain areas and activity of extra-tropical cyclones

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Year-to-year variability of winter rain events in the Sugadairakogen Highlands was investigated using 33-years daily records of rain/snow discrimination at the Sugadaira Montane Research Center, University of Tsukuba, and characteristics of atmospheric circulation in relation to the precipitation-phase changes were analyzed for 12 precipitation events by simple laser-type disdrometer observation with numerical weather simulation.

Keywords: winter precipitation, discrimination of rain and snow, extratropical cyclone, Japanese Alps, Sugadairakogen

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AHW28-03 Room:103 Time:May 20 09:30-09:45

Climate changes of the central Japanese Alpine area deduced from a modern analog method applied to the pollen compositio

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Among the various proxies of paleoclimate used in the world, the modern analog method (Polygon 1.5) for pollen composition proposed by Nakagawa et al. (2003) is an excellent way to estimate meteorological factors such as annual temperatures (degree) or precipitation (mm/y) in the Japanese islands. We tried to convert the pollen data taken from the lakes or morass in central Japan over several to a few tens thousands years ago using Polygon 1.5. The major data source is the pollen composition analyzed on the NJ88 core from Lake Nojiri.

Lake Nojiri at the northernmost part of Nagano Prefecture is an oligotrophic lake (4.6km2), surrounded by the cool-temperate deciduous broadleaved trees. Annual mean temperature is 9.2 degree, and annual precipitation is 1262 mm (AMeDAS: Shimanomachi, AD1979-2010). A scientific boring core named NJ88 was taken at 28 m deep off Biwa-jima in Lake Nojiri, and is composed homogenous silty clay with many thin layers of marker tephra, which enable age estimation of the core. The base of NJ88 core analysis is as old as 72 ka, and the time resolution analysis is about 80 year on average.

The reconstructed annual temperature in 72˜60 ka, is about 2.2 ˜ 5.0 degree, suggesting very cold climate in MIS 4. That in 60˜30 ka varies from 2.7 to 12 degree, showing general coolness with many abrupt warm intervals in MIS 3. The annual temperature in 30 - 15 ka is constantly as low as 2.7 degree, corresponding to the LGM of the coldest climate. During 15 to 11 ka, annual temperature shows a quick warming, that is, from 3.0 to 13 degree. Climate in 11 - 3 ka, is temperate. On the one hand, the reconstructed annual precipitation has a similar tendency to the temperate various. Reconstructed temperature and precipitation of the Holocene are almost same with the modern observation at Shinanomachi.

The temporal changes of TOC and TN amount analyzed on the NJ88 and NJ95 cores in Lake Nojiri, which imply winter temperature via biological productivity, show good correspondence to the reconstructed annual temperature both in orbital and millennial scales.

Climate parameters calculated from reconstructed data are also useful. For example, the temperature difference (Tyar) between the warmest month (MTWA) and the coldest month (MTCO) shows a negative relationship with annual and summer precipitation, r=-63 and -0.96 respectively, implying power balance of Siberian and Pacific air masses.

Paleoclimate reconstruction will be reported also for the pollen data from Lake Aoki, Lake Kizaki and Oahara morass.

Keywords: Polygon, Lake Nojiri, modern analog, paleoclimate

Japan Geoscience Union Meeting 2012
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AHW28-04 Room:103 Time:May 20 09:45-10:00

Inter-annual variation of the timing of snowmelt runoff in the Japanese Alps region

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Global-warming-induced shift in the timing of snowmelt runoff toward earlier in the year has been observed in western North America and others. To confirm whether such a phenomenon is occurring in Japanese Alps region, inter-annual variation of river discharge was analyzed for winter and spring seasons. Using the Water Information System of Ministry of Land, Infrastructure and Transport, Japan, we selected observation data of river discharge at totally 13 gauge stations for 10 rivers, of which headwaters are located in Japanese Alps or surrounding mountain ranges. Length of available data is different among the stations with 37 years at maximum and 6 years at minimum. The ”center time” (CT), which is the flow-weighted day-of-year (DOY), was computed as a measure of runoff timing. In the present study, January 1 was assumed to be the beginning of the water year, and data after June 1 were excluded in the analysis to avoid influences of discharge increase due to Bai-u front and/or typhoons. Maximum and minimum of computed CT were DOY68 (March 9) and DOY128 (May 8), respectively. For the rivers Jinzu, Hime, Narai and Tenryu, inter-annually decreasing trend was found, suggesting that the snowmelt runoff timing did shift toward earlier. However, both linear regression analysis and Mann-Kendall rank statistic rejected the significance ($p < 0.05$) of the trend. This is probably due to insufficient length of observation records and to highly variable CT at shorter timescales (i.e., year by year). Correlation analysis for inter-annual variation of CT with those of air temperature and precipitation amount clarified different features among the rivers. For the Jinzu River (including its tributary, the Ida River) and Hime River having their sources in northern part of the Northern Alps or the Ryohaku mountains, the timing of snowmelt runoff tends to shift toward earlier, as air temperature in January is higher. For the Sai River and Narai River, which rise in southern part of the Northern Alps or the Central Alps, snowmelt runoff in late spring is increased by higher temperature or greater precipitation in April-May. Runoff timing for the Tenryu River, of which watershed covers eastern part of the Central Alps and western part of the Southern Alps, is affected by both winter temperature and spring temperature as well as spring precipitation. For the upper Chikuma River and Fuji River system (including Kamanashi River and Fuefuki River), which flow from eastern part of the Southern Alps or the Kanto mountains, river discharge strongly depends on precipitation rather than air temperature, indicating minor contribution of water from snowmelt. As a general tendency over the region, temperature in January controls not only runoff timing but also amount of discharge in spring, and in many stations significant, negative correlations was found between temperature in January and discharge in April. Thus, it is concluded that temperature rise in winter due to global warming is likely to decrease river discharge in spring over the Japanese Alps region. For rivers less sensitive to temperature (e.g., upper Chikuma River and Fuji River system), river discharge would be affected by changes in precipitation pattern, if those were altered by global warming.

Keywords: snowmelt runoff, inter-annual variation, Japanese Alps region, global warming, hydrological response

Japan Geoscience Union Meeting 2012
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AHW28-05 Room:103 Time:May 20 10:00-10:15

Spatial-temporal variations in isotopic composition of precipitation over the Japan Alps area

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Precipitation samples, collected monthly at 14 locations over the Japan Alps area from July 2010 to June 2011, were served for isotopic analyses. The weighted mean values of $d^{18}O$, dD and d-excess ranged from -10.89 to -14.10 permil, from -77.25 to -93.2 permil and from 8.88 to 11.60 permil, respectively. Significant negative correlations were found between weighted mean values of d18O and dD and altitude. The slopes of altitude effect for $d^{18}O$ and dD were -0.12 permil/100m, -0.90 permil/100m, respectively. Although d-excess was low in summer and increased gradually toward winter in all the points, temporal patterns in monthly $d^{18}O$ were divisible into two groups, mountainous region (more than 1000 m of altitude) and basin region (less than 1000 m of altitude), according to cluster analysis. The high $d^{18}O$ in January was commonly found in mountainous regions, whereas monthly $d^{18}O$ of basin regions gradually decreased during winter season. Significant negative correlations between monthly $d^{18}O$ and altitude were found through warm seasons except June, whereas no correlation in November, December and January. Especially, no significant but positive correlation was found in January. To discuss this inverse relationship between altitude and $d^{18}O$ in January, we investigated the relationship between precipitation and synoptic conditions in winter and indicated that wintry pressure pattern had mainly brought precipitation in January. Therefore, high $d^{18}O$ of precipitation in January could be attributed to water vapor from the Japan Sea. These results suggest that isotopic composition in precipitation over Japan Alps area is controlled by altitude effect in warm seasons and affected by synoptic conditions in winter.

Keywords: water stable isotopes, precipitation, Japan Alps area

Japan Geoscience Union Meeting 2012
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AHW28-06 Room:103 Time:May 20 10:45-11:00

Geo-environmental Monitoring on Post-fire alpine slopes of Mount Shirouma-dake, northern Japanese Alps

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This is the continuous study to clarify the geo-environmental changes on the post-fire alpine slopes of Mount Shirouma-dake in the Northern Japanese Alps. The fire occurred at May 9, 2009 on the alpine slopes of Mount Shirouma-dake, and the fire spread to the *Pinus pumila* communities and grasslands. Although the grass had a little damage by the fire, the *Pinus pumila* received nearly impact of the fire. In the *Pinus pumila* communities where the leaf burnt, forest floor is exposed and become easy to be affected by atmospheric condition such as rain, wind, snow, and etc.

First, we illustrated a map of micro-landforms, based on geomorphological fieldworks. We observed these micro-landforms repeatedly for two years after the fire. As the results of the observation, it is clear that remarkable changes of these micro-landforms have not occurred but some litter on the ground surface under the *Pinus pumila* communities are flushed out to surroundings. The *Pinus pumila* communities established on the slopes consists of angular and sub-angular gravel with openwork texture, which are covered by thin soil layer. Therefore, it is necessary to pay attention to soil erosion following the outflow of the litter.

In addition, we started the observations the ground temperature and soil moisture, under the fired *Pinus pumila* communities and the no fired *Pinus pumila* communities, to find influence of the fire. The ground temperature sensors were installed into at 1, 10, and 40 cm depth. The soil moisture sensors were installed into at 1 and 10 cm depth. On the post-fire slopes, the number of times of diurnal freeze-thaw cycles do not increase, but the period of seasonal frost is extended for one month.

Keywords: Fire, Alpine zone, *Pinus pumila*, Slope erosion, Ground temperature variation, Shirouma-dake

Japan Geoscience Union Meeting 2012
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AHW28-07 Room:103 Time:May 20 11:00-11:15

Direct observation of permafrost on Mt. Fuji

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This research is a part of our interdisciplinary research project to understand permafrost on Mt. Fuji (3776 m asl.), to monitor its change and to evaluate the impact from changes of climate and volcanic activity on surrounding environments. In the summer of 2008, two boreholes about 3 m deep were dug on the summit area, and ground temperatures and meteorological parameters, such as air temperature and precipitation, were started to monitor automatically. One borehole (K site) is located on a small ridge in the flat area between the summit crater and outer ridge, where snow is mostly blown off by strong wind in winter. The other borehole (T site) is located at a bottom of small depression, where snow is preferentially accumulated.

Contrary to the assumption of the previous studies, permafrost absence was confirmed in both boreholes. Although frost penetration in winter reached deeper than 3 m at K site, rapid increase in ground temperature followed heavy rainfall events until early October. The highly permeable debris allows heat advection by infiltrating rain-water, which prevents the ground from being frozen throughout a year. The mean annual ground temperatures of T site were higher than those of K site, because snow cover in winter prevented the ground from cooling.

Then, we planned to dig a deeper borehole for permafrost monitoring at a most windy and less water-permeable site, and succeeded to make a 9.7 m deep borehole on the ridge near the Hakusan peak in late August 2010. Fifteen temperature sensors were installed in the borehole and recording of the data was started. Unfortunately, the data logger for the borehole was damaged by the lightning in November 1, 2010, and replaced with new logger in early July 2011. The maximum thaw depth was about 2 m in 2011, and the temperature at the depth of 9.7 m was about -3 deg C through the summer. Thus, it is almost certain that the permafrost is present at the site. We hope that the temperature data throughout a winter will be successfully obtained during the next visit in May 2012.

Keywords: permafrost, Mt. Fuji, ground temperature, climate warming

Japan Geoscience Union Meeting 2012
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AHW28-08 Room:103 Time:May 20 11:15-11:30

Effectes of roots on slope stability in mountain area

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In mountain area, many landslides occur because of the steep terrain. Although there are many studies on effects of roots on slope stability, only few studies have been conducted in steep mountain area. Effects of roots on the slope stability needs to be understood to preserve stream ecosystems as well as to develop better mitigation measures for preventing disasters. In this study, we analyzed simple physically based model to clarify effects of roots on the slope stability. We also conducted aerial photograph and field investigations at Ikawa University Forest in steep Akaishi Mountains, central Japan. Physical analysis revealed that root strength at the soil layer boundaries is an important factor to evaluate effect of roots on the slope stability. Frequency of shallow landslides examined by aerial photograph investigations was highest in the forests 0-20 yr after clearcutting. Decay of root strength by cutting may have induced occurrence of these shallow landslides. Cone penetration tests revealed that slide surface of many of these landslides locates at the boundary between regolith and bedrock. These investigation results correspond to our physical analysis.

Keywords: roots, landslide, mountain area, artificial forest

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AHW28-09 Room:103 Time:May 20 11:30-11:45

Fluctuations of the glacier after the Younger Dryas period in the Japanese Central Alps estimated from TCN dating

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This study estimated the timing of the glacier recession from TCNs (Terrestrial Cosmogenic Nuclides) exposure ages of bedrocks and a moraine on the Komakai-no-ike Cirque in the Central Japanese Alps. TCNs enable us to know how long rock surfaces have been exposed on the ground. At the place like a cirque bottom, accumulation of TCNs in rocks had started evidently after the glacial covering and denudation. So, the exposure age seems equal to the age from being released from the glacier. The formation age of cirque and the glacial advance period have been estimated from TCNs dating of glacial deposits (Aoki, 2000; Aoki, 2003), but the timing and the recessional process of glacier have not been clear. It is possible to consider that the glacier retreat and disappearance corresponds to the climatic changes, it is very important to estimate the timing of glacier recession in restoring the fluctuations of paleoclimate. Therefore, we measured the concentration of ^{10}Be of bedrocks and a moraine in the cirque, using Micro Analysis Laboratory, Tandem Accelerator (MALT), The University of Tokyo. As a result, it seems that the last glacial advance period in the Komakai-no-ike Cirque corresponds to the Younger Dryas period, and the glacier began to retreat and loss over thousands of years after that.

Keywords: cirque, glacier, the Younger Dryas period, Terrestrial Cosmogenic Nuclides (TCN), exposure age, Accelerator Mass Spectrometry (AMS)

Japan Geoscience Union Meeting 2012
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AHW28-10 Room:103 Time:May 20 11:45-12:00

Physiographic effects of landslides on landscape evolution in Northern Japanese Alps

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Mosaics of landscape are present in the alpine and subalpine zones of Northern Japanese Alps, central Japan. The formation of these mosaics is considered to have been affected by complex natural environments of the mountain areas such as topography, surface geology, soils, climates, and vegetation as well as long-term geohistory since the Last Glacial. Although large landslides occur in Northern Japanese Alps, little attention has been given to sudden and short-term (or prolonged and long-term) effects of slope changes by landslides on landscape evolution. In this presentation, we describe four examples from geomorphological and geoecological points of view: 1) Tsugaike-Shizenen moor in east of Mount Korengeyama, 2) Nagaikedaira in north face of Mount Shiroumadake, 3) Tsukumoike moor on Mount Eboshidake, and 4) Takamagahara moor in upper Kurobe River. Consequently, we summarize the present status of these studies and outline the future direction of this research field.

Keywords: landslide, landscape evolution, Quaternary geology and geomorphology

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AHW28-11 Room:103 Time:May 20 12:00-12:15

Annual channel migration and environmental diversity in the upper reaches of the River Azusa, Central Japan

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Kamikochi Research Group annually made geomorphological maps since 1994 in the upper reaches of the River Azusa, central Japan. Several species of willows such as Salix arbutifolia occur in the patches and as isolated trees in the active riverbed. This study aims to discuss the relationships between geomorphic processes of the riverbed and environmental diversity for vegetation establishment in the active riverbed in the Kamikochi valley. The braided channels in the active riverbed are buried by sediments and new channels are excavated in a severe flood event which occurs once in several years. There are some stable spots in bars and/or islands in the active riverbed where only slight landform change occurs for five or more years. In those spots pioneer plants germinate and grow to young pioneer patches. When lateral erosion occurs, destruction and/or size reduction of the pioneer patches are caused. If a little seedling willow patch remains not to be destroyed for more years, it becomes a grown pioneer patch, finally old isolated trees. Therefore the patches in various age and size classes are found in the active riverbed. The fluvial geomorphic processes provide dynamic environmental diversity for the pioneer species in the active riverbed and cause the destructions and re-establishments of vegetation. As a result the vegetation diversity is created in the Kamikochi valley.

Keywords: channel migration, braided channel, gravel bed river, environmental diversity, River Azusa, Kamikochi

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AHW28-12 Room:103 Time:May 20 14:30-14:45

Mapping of Leaf Area Index over Japan using Terra/MODIS data

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It is required to estimate carbon budget accurately, since carbon dioxide concentration in the atmosphere would accelerate global warming. Terrestrial vegetation fixes carbon from the atmospheric carbon dioxide by photosynthesis and biological models utilize leaf amount as one of important parameters. Therefore, it is important to estimate distribution of leaf amount of ecosystems accurately in a large area. Satellite image data provide land surface information and are used mapping of various land surface information including leaf area index (LAI). A simple LAI mapping method was developed based on Beer-Lambert law and applied for 32-day MODIS images over Japan obtained in 2002 and a LAI map was produced.

Eight-day MODIS composites produced by NASA was used and rearranged for 32-day mosaics except August using the minimum value within each 32 day interval. The normalized difference vegetation index (NDVI) was computed using the 32-day mosaics, and noises were reduced using the principal component analysis and its inversion.

The following equation was derived using Monsi & Saeki's equation based on Beer-Lambert's law for LAI.

$LAI=-\ln(1-PARr/PAR0-(a+b*NDVI))/k$ (1)

where PAR: photosynthetcally active radiation, PARr/ PAR0: reflectance of visible wavelength, k: extinct coefficient. The constants a and b are determined based on field measurements or literature. It is difficult to determine k accurately, but 0.4 for needle-leaf, 0.48 for needle-broad-leaf mixed, 0.56 for broad-needle-leaf mixed, 0.64 for broad-leaf for bamboo shrub were assigned by the literature. Distribution of each category was determined using a MODIS based forest type map and LAI was mapped using reflectance factor of visible channels, NDVI and equation (1)

Average LAI was 6.7 a rather large value and LAI range was small. Seasonal changes of LAI were different area by area on the monthly LAI maps.

Keywords: LAI, Beer-Lambert's law, MODIS, Japanese archipelago, seasonal change

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AHW28-13 Room:103 Time:May 20 14:45-15:00

Basic study on the Life Cycle Assessment of the local wood used in the construction of houses

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In late years of Japan, wood as the natural material is reviewed from the viewpoint of comfort and health maintenances. Maturity advances, and the forest resource in Nagano prefecture area enters felling period. In a condition that the effective profit utilization is done. The forest area of Nagano prefecture occupies approximately 80% of the prefecture soil surface. As the top 3 of wide forest area in Japan, there are Hokkaido (55,380km^2), Iwate (11,740km^2) and Nagano (10,600km^2) , and Nagano prefecture is endowed with forest resource-rich environment. It is essential to use local wood to succeed the local forest of Nagano for sustainable assets in the next generations. Because the achievement is tied to our security, reliable living, it is necessary to promote local production for local consumption of the wood.

The log felled in forest was accumulated to the market, and they were purchased by each sawing factory, and sawing and drying were performed in a factory, and the finished wood was carried in to the building site. It was cleared by a result of the preliminary investigation about the manufacturing process of the timber tree in Nagano. The wood is brought into the spot after a multi-stage process in this way. We understood that the circulation of the wood was divided by each process. It becomes one of the causes that promotion of the wood use does not advance to enough that a prospect of the traffic of the wood is bad.

The life cycle analysis (LCA) to use in this article is the same as technique to evaluate the environmental load in the life cycle of the product mainly. This method is the technique that is important to promote the visualization of the manufacturing process until process of the manufacture and spot import.

One of the medium-and-long term aims in a series of studies including this article is what a construction company and an end user make the decision making tool to change it to the product that there is less the environment load at the time of housing construction and show. Atmospheric carbon is absorbed in wood and is fixed, but the quantity of true fixation does not become clear if carbon released in the manufacturing process is not deducted. We calculated the income and expenditure of the carbon as carbon balance in this study.

The second aim clarifies results level of the traffic of the wood in each process and is to make a part becoming the bottleneck of the wood promotion clear.

We calculated quantity of in the forest of Nagano wood existence and the quantity of felling to idealize as a test. We aim for clarifying real quantity for it in this article.

We clarified the quantity of in the raw wood market handling material volume and quantity of shipment material volume from a sawing factory by hearing investigation. Based on the result, We clarified the technique toward generalization of the carbon balance calculation of the timber tree in this article.

Keywords: Carbon Balance, Local wood, Life cycle Assessment, CO_2 emission, Wooden houses

Japan Geoscience Union Meeting 2012
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AHW28-14 Room:103 Time:May 20 15:00-15:15

A field warming experiment with OTC in a cold region, Sugadaira: changes in biomass, species richness, and snow depth

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Aim: Acceleration of snow melt with accompanying global warming may cause the change during a vegetable growing period, and may have serious influence on the vegetation of a snowfall zone.

Then, this research investigated the influence which the acceleration of snow melt with accompanying warming has on development and species diversity of vegetation by field warming experiment for the Japanese-pampas-grass dominated grassland in the Sugadaira plateau of a cold region.

Method: The experiment was conducted in the grassland site of Sugadaira Montane Research Center, University of Tsukuba. Every autumn, the facilities managers remove all of the aboveground plant parts in the grassland to prevent the vegetative succession from grassland to forest.

The annual mean temperature at the site was 6.5 ?C and the average monthly temperature ranged from 19.4 ?C in August to ?5.6?C in February, while the mean annual rainfall was 1,226 mm and the annual mean of maximum snow depth was 102 cm for the years 1971?2006. The first snow in the site is usually observed in the beginning of November. All snow melt in mid-April.

Five warming experiment plots and five control plots each of 1 m x 1 m were placed in the grassland.

The four lateral sides of the warming experiment plots were covered by the transparent panel about 2 m high, and the upper part was open (Open top chamber, OTC).

Snow depth and temperature at 1 m above ground in ten plots were recorded. Moreover, species composition and the degree of plant cover from immediately after snow melt were recorded at intervals of one month from one week. In September when plant biomass becomes the maximum, all above-ground plant parts were collected in each plot, and weight of these samples were measured after drying.

Result: Compared with the control plots, an average of 1.4 ?C temperature was higher in the OTC plots throughout the experimental period. Snow dept was 33 cm lower and the snow melt day which was defined as the day when all snow in an plot disappeared was 22 days earlier in the OTC plots.

These differences in temperature and snow melt affected the vegetation development. Since vegetable growth was started immediately after snow melt, the length of vegetable growing period was prolonged in the OTC plots. On the other hand, in the control plots, the plant cover increased rapidly during a short period. As a result, two months after from snow melt, the degree of plant cover and the number of species emerged had no significant differences between OTC and control. However, the OTC plots had higher final biomass and species richness than the control plots in September.

Discussion: Temperature increased and the snow melt was accelerated in the warming plot. Consequently, vegetable growth was also increased, and thus the final plant biomass and the number of species per area were tended to be high in warming plots. However, the vegetation tended to grow rapidly after snow melt in the control plots. Our study suggests that when snow melt accelerated with accompanying warming, vegetable growth is not simply accelerated, but shows the delay in reaction to warming.

Keywords: Field warming experiment, Biodiversity, Biomass, Grassland, Snow depth

Japan Geoscience Union Meeting 2012
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AHW28-15 Room:103 Time:May 20 15:30-15:45

The adaptation mechanisms by the altitude-versatile plant, *Arabidopsis kamchatica*: ecology, physiology and genes

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Arabidopsis kamchatica ssp. *kamchatica* (Brassicaceae) is a perennial plant and versatile in terms of the altitudinal range of its habitats. However, its subspecies *kawasakiana* is an annual plant and lives only under 100 m alt. How the subspecies *kamchatica* adapt to wide altitudinal range? Why are these subspecies so contrasting in life-history and altitudinal range? Answering these questions advances our understanding to the mechanisms of plants' adaptation along altitude and the impact of global warming to plants. These subspecies are not only ecologically interesting but also genetically tractable because these are most closely related to the plant model, *A. thaliana*. We have been studying (1) life-history and natural selection in wild populations, (2) genetic differentiation in traits of life-history, resistance and stress tolerance using common garden experiments, (3) local adaptation using transplant experiment and (4) genes relevant to these differentiation and adaptation.

(1) We set permanent quadrats in 28 populations of the subspecies *kamchatica* in five mountain regions and monitored all focal plants by individual marking for three years. Life-history parameters such as survival, growth, fecundity and herbivory changed along altitude, indicating the natural selection and the population maintenance mechanism change along altitude. Although low-altitude populations exhibit almost annual-type life-form high-altitude populations show typical perennial life form within the same perennial subspecies.

(2) We collected seeds from 29 wild populations of the both subspecies and grew them in the common laboratory. Life-history traits (flowering timing, germination timing, growth and plant size), herbivory resistance (trichome) and stress tolerance (heat tolerance) were measured and most of them showed clines along original altitude, indicating historical natural selection and consequent genetic differentiation along altitude.

(3) We transplanted 12 and four populations of the subspecies *kamchatica* and the subspecies *kawasakiana* to low- (150 m), middle- (1300 m) and high-altitude (2700 m) gardens and monitored their survival, fecundity and herbivory for two years. All plants dyed in the first winter at the high-altitude garden. At the remaining gardens, plants from lower population showed better performance at lower garden whilst plants from higher population showed better performance at higher garden, indicating home-site advantage and that populations have evolutionary adapted to their altitude.

(4) For genome-wide screening of polymorphic genes, we used genome-tiling-array for eight and four populations of the subspecies *kamchatica* and the subspecies *kawasakiana*. We detected >3000 polymorphic genes either between subspecies and between *kamchatica* populations. Significantly more disease-resistance and temperature-inducible genes were found in those polymorphic genes compared to neutral expectation. We also used next-generation sequencer to simultaneously analyse many plants for candidate genes and found GL1, that control trichome production, to be important for altitudinal adaptation. The genes showed correlation between allele frequency and altitude, and strong disruptive selection between populations.

Keywords: altitudinal adaptation, adaptive evolution, local adaptation, cline, disruptive selection, home-site advantege

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AHW28-16 Room:103 Time:May 20 15:45-16:00

Consideration of climate factors concerning geographical distribution of fungi in Japan

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Fungi play an important role as decomposer, symbiont and parasite in land ecosystem. We have studied about geographical distribution of fungi and effects of climate change on fungal distribution. The results of these studies will be reported in this presentation.

Keywords: fungi, geographical distribution, climate change

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AHW28-17 Room:103 Time:May 20 16:00-16:15

On the new plant pathogenic fungus attacking Miscanthus sinensis at Japan Alps

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We clarified a taxonomic status of a new fungal plant pathogen attacking Miscanthus sinensis, a dominant plant species in a grassland community at SMRC on the Sugadaira plateau, c. 1300m alt., Nagano, central Japan. The 35hr of grassland has been maintained by artificial removes of all of the aboveground plant parts, every autumn since 75 years ago. In the study site, M. sinensis was mainly infected by two plant pathogenic fungi; smut fungus, Ustilago kusanoi (Basidiomycota) and an unidentified species of Ascomycota. Both of the diseases remarkably decrease the growths and sizes of the hosts. Latter unidentified fungus causes leaf blight-like disease with characteristic symptoms on living leaves of M. sinensis. Initially white lesions emerge at the center of leaves in the end of May, and gradually they increase in length and width. Finally many minute fruiting bodies (lip-shaped apothecia) are produced on legions (in July to Augst). The incidence of the fungus emerged early in June, and peaked at July. We recorded the incidence of the fungus observed in 2708 subplots, among 6000 1 x 1-m subplots within a 60 x 100-m area in the study site. Based on the result of the molecular phylogenetic analyses, observations on ecological and morphological characters, the present causal agent of Miscanthus is identified as a species of genus Naemacyclus, Rhytismatales (Ascomycota).

Keywords: biodiversity, microbe, interaction, taxonomy, microbiology, inventory

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AHW28-18 Room:103 Time:May 20 16:15-16:30

Ecology of Japanese dormouse in central montainous area

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A Japanese dormouse Glirulus japonicus (TL 68˜84mm) is arboreal small-sized mammal, which is endemic species in Japan and is designated as a Natural Monument in Japan. It is nocturnal and hibernates in winter, and rest in tree hollows etc. during daytime from spring to autumn. It inhabits forests in Honshu, Shikoku, Kyusyu and Dogo Isl. of the Oki Isls.

More information on the dormouse habitat distribution was collected from Central Japan, thus the many dormice may inhabit in central mountainous area (Sugiyama and Kadowaki, 2010).

Feces were collected from May to October in 2011, and food habits of the dormouse were examined by fecal analysis. Fragments in feces were identified to arthropods, rinds of fruits and others, pollens and seeds et al. Dormice fed arthropods and rinds of fruits in all months. More arthropods were examined in May, detection of rinds of fruits and others were apt to increase after August, and pollens were examined in spring. This trend supports the seasonal change of food habits of the Japanese dormouse that has suggested (Ochiai et al., 2011)

Daily rest sites of dormice were examined by radio tracking from June to September in 2010 and from June to November in 2011. Dormice used on tree and nest boxes settled to trees for the rest sites, but little used underground. Trees used by dormice for the rest site were thick (greater DHB) and had more hollows (Tamaki et al., 2011).

Ochiai, N., Kadowaki, S., Tamaki E. and M. Sugiyama. 2011. Food habits of a Japanese dormouse Glirulus japonicus by by fecal analysis. The abstracts of the annual meetinfg 2011 of Jpanese Alps Inter-University Cooperative Project: 121.

Sugiyama, M. and S. Kadowaki. 2010. Creation and publication of a habitat distribution map for the Japanese dormouse beased on information available on the Web. Technical report, University of Tsukuba 31: 62-66.

Tamaki, E, Kadowaki, S., Ochiai N. and M. Sugiyama. 2011. Daily rest sites selection of a Japanese dormouse Glirulus japonicus. The abstracts of the annual meetinfg 2011 of Jpanese Alps Inter-University Cooperative Project: 122.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AHW28-19 Room:103 Time:May 20 16:30-16:45

The cryptic genetic diversity of a mountain ant *Myrmica kotokui* (Hymenoptera: Formicidae) in Japan Alps

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Modern molecular phylogenetic techniques have revealed that some species comprise several genetically distinct species (cryptic species). The discovery of cryptic species is essential for evaluation of biodiversity, and the investigation of their distribution is crucial for biogeography and conservation biology.

Myrmica kotokui is a common species in Japan, which is distributed from Hokkaido, northern Japan, to Yakushima Islands, southern Japan. The ant species is thought to be originated form Eurasia and adapted to cold-temperate climate, thus the ant is restricted to high elevation in lower latitudes. For example, *M. kotokui* is restricted at altitudes of approximately 1,000 to 2,000 m in Japan Alps. The segregated distribution indicates that the ant can be divided into some genetically distinct lineages for each mountain region.

To test the hypothesis, we collected ant colonies at 36 sites from five mountain regions in Nagano, central Japan, and reconstructed molecular phylogeny of the mitochondrial *COI* gene. The phylogeny of the ants reveals four independent lineages, suggesting that there are some cryptic species in *M. kotoku*i, which has been known as a single morphological species. The distribution pattern of the ant lineages did not support our hypothesis: genetic differentiation among different mountainous regions. All the lineages were widely distributed across all regions. On the other hand, we found a geographic pattern in the vertical distribution of the lineages; the lineage Mk-3 was distributed in higher elevation, and the others (Mk-1, Mk-2 and Mk-4) were in lower elevation. Thus, intra-species lineages of *M. kotokui* do not segregate by each mountain region but by elevation.

Did the genetic differentiation of the lineages in *M. kotokui* occur in Japan Alps or did the already-diverged lineages in the Eurasian continent migrate to Japan Alps? The differentiation of the lineages does not seem to occur in Japan Alps because 1) there is no physical barrier between altitudes in Japan, and 2) the genetic distances among the lineages are too large to be generated parapatrically. Thus, the stratified distribution of the ant lineages along altitudinal gradient may have been formed through multiple migrations from the continent and the following habitat segregation among differently coldness-adapted lineages. All in all, cryptic highland-lineages in the *Myrmica* ant are suggested and propose further hidden biodiversity in higher elevation.

Keywords: cryptic species, biodiversity, altitudinal gradient, molecular phylogenetic tree, mitochondrial *COI* gene, ant

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AHW28-20 Room:103 Time:May 20 16:45-17:00

Changes of the land use and decline of the endangered butterfly, *Shijimiaeoides divinus barine* in Azumino

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The large shijimi blue, *Shijimiaeoides divinus barine* is distributed in limited areas of Nagano Prefecture in Japan at present. It has been designated an Endangered Species (CR+EN) by the Ministry of the Environment. In Azumino City, Nagano Prefecture, the volunteer organization has been in active to recover the natural population of this butterfly by the method of releasing pupae from 1999. However, *Trichogramma chilonis* is a severe mortality factor of the egg stage of *S. divinus barine* . Therefore, the natural population was not recovered.

S. divinus barine eggs were sampled and *T. chilonis* adults were collected by sticky trap in Azumino City and Tomi City where the natural population of *S. divinus barine* has survived in Nagano Prefecture. The percentage of parasitism was 50% or more in Azumino City. On the other hand, in Tomi City, the range of percentage of parasitism was from 30% to 40%. The number of *T. chilonis* captured by sticky trap in Azumino City was higher than that in Tomi City.

The difference in the habitats of *S. divinus barine* between two areas was the management method of the grassland. The farmer performs environmental management of ridges in the field, such as mowing and bush burning, in Tomi every year. On the other hand, in Azumino City, since the habitat of *S. divinus barine* was in Alps Azumino Natural Government Park, bush burning was forbidden. The relationship between egg parasitism of *T. chilonis* and the management methods (mowing, bush burning) of inhabitant area of *S. divinus barine* was suggested.

When did bush burning begin in Japan? The andosol which was formed by the bush burning in the Jomon period is widely distributed in Nagano Prefecture. It is known that the distribution areas of *S. divinus barine* overlapped the andosol and imperial pastures. The semi-natural grassland which is suited to *S. divinus barine* has been maintained from the Jomon period by pasturage or bush burning in Nagano Prefecture. However, after the Edo period, the paddy field was reclaimed in Azumino, and the pastures were lost. Was *S. divinus barine* exterminated? The answer is NO. In order to use *Sophora flavescens* as a herb etc., it planted in ridges of a rice field, the bank of the irrigation canal, etc. Mowing and bush burning were performed periodically. Thus, the habitat of *S. divinus barine* has been maintained. However, the major land improvement enterprise was undertaken around from 1962. Sem-natural glassland vegetation including Sophora flavescens was lost and bush burning was stopped. Therefore, the environment where *S. divinus barine* can live has disappeared.

An experiment of the bush burning was carried out in Azumino City, Nagano Prefecture on March 29, 2009, in order to verify the effect of bush burning on parasitism and the survival of *S. divinus barine* . Immediately after bush burning, the cages were set up in the burned area and the control area respectively.

Afterward, *S. divinus barine* eggs were taken for observation, and *T. chilonis* adults were collected by sticky trap inside and outside the cages. The percentage of parasitism on June 9 inside the cage was 2.3% in the burned area and 30.3% in the control area. The number of *T. chilonis* captured by sticky trap inside the cage in the control area was a total of 21 individuals from May 5 to June 9. However no individual was captured in the burned area. It was given as a conclusion that the bush burning had an effect on parasitism of *T. chilonis* on *S. divinus barine* eggs.

In Alps Azumino Natural Government Park, bush burning has become to be performed by the results of our researches every year. As a result, *S. divinus barine* adults were observed in 2011 for the first time in about 15 years.

Keywords: *Shijimiaeoides divinus barine*, *Trichogramma chilonis*, *Sophora flavescens*, bush burning, imperial pastures, semi-natural grasslands