

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 °C 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

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

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

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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: Shinanomachi, 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 (T_{yar}) between the warmest month (MTWA) and the coldest month (MTCO) shows a negative relationship with annual and summer precipitation, $r=-0.63$ 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

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

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 $d^{18}O$ 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

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

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

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

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 ¹⁰Be 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)

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 Korengyama, 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

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

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.

$$LAI = -\ln(1 - PAR_r / PAR_0 - (a + b * NDVI)) / k \quad (1)$$

where PAR: photosynthetically active radiation, PAR_r / 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

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 (55,380km²), Iwate (11,740km²) and Nagano (10,600km²), 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, CO₂ emission, Wooden houses

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 depth 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

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 died 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 advantage

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

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 lesions (in July to August). 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

Ecology of Japanese dormouse in central mountainous 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).

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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 from 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. kotokui*, 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

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 grassland 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

The resolution dependency of the topographic effect on solar radiation flux on a complex topography

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Introduction

The solar radiation flux is the fundamental energy source for carbon, heat and water cycle. The topographic condition affects the radiation amount over complex topography by its shadow and inclination. The in-situ observation in the mountainous area often suffers from such topographic effects. On the other hand, the scale of the meteorological consideration still stays more than km scale or just one point observation. The resolution does not seem to be enough for mountainous area. Here, the solar radiation flux on the surface of mountainous area was studied, where we have many studies relating to "Japanese Alps Inter-University Cooperative Project".

Data and method

The global solar radiation was estimated for 360x160 points with 100m distance in 36 km x 16 km area including Mt. Norikura in central mountainous area in Japan. The altitude ranges from 600 m to 3000 m. The Takayama field station of Gifu University is located at 1342 m. The hourly global solar radiation flux, temperature and pressure data there in 2010 were used to estimate the solar radiation flux in the area. Digital Map 50 m Grid (Elevation) by Geospatial information authority of Japan was also used. The elevation data are averaged in 100 m, 200 m, 500 m, 1000 m, 2000 m and 5000 m to know resolution dependency. The skylines from each target point were calculated using elevation data in the area of 70 km distance for 50 m grid and about 200 km for larger grids. The difference is due to the computational power, but almost all points in fine scale elevation data catch the skyline near area because fine elevation data resolves mountains well. The sky view factor was calculated using the skyline data, but the sky was projected onto the inclined surface. It often shows lower value than it for horizontal plain. The observed solar radiation was divided into direct and diffusive components using Spitters et. al. 1984 or Liu and Jordan 1960. The latter includes air mass consideration. The shadows of mountains are considered for the direct component flux and sky view factor of the diffusive component and the reflection from ground surface from other area are assumed to reach the target area. The total solar radiation received under horizontal unit area, that means large inclined area, was computed.

Results and discussion

The standard deviation for annual mean solar radiation flux distribution is increased from several Wm^{-2} for 5000 m grid to 30 Wm^{-2} for 50 m grid with forest albedo (0.15). The mean solar radiation is about 150 Wm^{-2} . The increasing tendency does not show saturation. The finer scale produces larger variation. The increasing is rapid for valley area under 500 m grid. The tendency is strengthened by higher albedo. The above results are for inclined surface under unit horizontal area. Heat is exchanged in inclined surface but usual observation of global radiation is done horizontally. In such a case, the standard deviation stays only about 6 Wm^{-2} . The inclination of surface is a major reason of the spacial variation. The difference between horizontal and inclined surface can be a reason of the imbalance of heat budget analysis over slope and it is necessary to be counted in observational data analysis.

The comparison between the observed global radiation of Takayama evergreen coniferous site (TKC) at 800m and the estimated one for horizontal plain shows 10% mean bias error for fine days, but the difference become much larger for cloudy days. Sometimes TKC observation shows larger value than Takayama station in spite of altitude difference due to local weather condition. The facts indicate the limitation of the approach here. Finally, the estimated results with snow albedo in winter and with forest albedo in other seasons are produced hourly with 50m grid elevation data for 2010 in the area. It may be useful for the solar radiation data in the area.

Keywords: Solar radiation, Japanese alps, topographic effect

Vegetation and climate history for the past 34,000 years based on the sediment core analysis from Lake Aoki, Nagano Pref

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Lake Aoki is an oligotrophic lake located in the northwestern part of Nagano Prefecture. The lake is 1.8 km² large, and 58 m deep in maximum. The sediment core analyzed was taken at a site of 55 m depth near the central basin of the lake, and is as long as 28 m. It consists of silty clay with many thin lamina of sand. Maker tephra bed identified and ¹⁴C age measurement enable age estimation of the cored sediments as old as 34,000 years ago.

Pollen analysis and total organic carbon content (TOC) measurement were performed for the cored sediment in short intervals. On the basis of pollen composition, vegetation change for the past 34 ka as follows; dominance of arctic conifer trees associated with cool-temperate deciduous broad-leaved trees in 34 to 30 ka, predominance of arctic conifers in 30 - 15 ka suggesting the Last Glacial maximum, quick change from arctic forest to cool-temperate forest in 15 to 12 ka, and stable cool-temperate deciduous broad-leaved forest in 12 to 2 ka.

TOC, a paleoclimate proxy, which can show winter temperature via plankton productivity in lake, shows quasi-periodic fluctuation which means warmness concordant with pollen composition. But dilution by non-organic clastic sediment decreases TOC contents in a few horizons, implying increases of erosion of the neighbor mountains.

A sediment core of 28 m length recorded well climate condition and vegetation history around the Northern Japanese Alps since the Last Glacial maximum

Keywords: pollen analysis, Lake Aoki, total organic carbon, Last Glacial Maximum, Japanese Alps, Japanese central highland

Monitoring rockwall erosion and soil transport in an alpine area, Southern Japanese Alps

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Purpose and methodology

Monitoring of rockwall dynamics is undertaken in the Mt. Ainodake area, Southern Japanese Alps, in an attempt to determine contemporary rates of erosion, amount of debris production and transport and to analyze their controlling factors. In August 2010 a new monitoring site was established on the Aresawa rock-slide scarp, where observations highlight climatic conditions (e.g. freeze-thaw process, snowmelt and heavy rain) and bedrock conditions (e.g. rock joints, rock mass strength and micro-topography). The new monitoring system is combined with foregoing monitoring campaigns on (1) pre-failure movement of the Aresawa headscarp area (Nishii & Matsuoka 2010), (2) soil movement associated with freeze-thaw action on the mountain-top slope (Matsuoka 1998, 2005) and (3) meteorological conditions (e.g. air temperature, precipitation and wind direction and speed), towards comprehensive evaluation of high-mountain geodynamics and sediment budget.

The following methods permit visual, quantitative and continuous observations of the dynamics of the rockwalls, where Matsuoka (1990, 2001) conducted preceding measurements.

- Photo-evaluation of shattered area on painted rockface
- Manual collection of fallen debris from painted rockface
- Automatic recording of rock-joint opening and rock temperatures (at 1, 10, 40 cm depth)
- Visual observation of rockface and foot slope with interval camera (daily) and terrestrial LiDAR (annually).

Continuous data have so far been acquired from August 2010 and October 2011 (see Figure) unless some interruption resulted from consumption of battery and extraordinary operation of the interval camera. The camera displayed limited snow cover on the rockface even in mid-winter, which was supported by large diurnal amplitudes of rock surface temperature. As a result, the rockface frequently experienced diurnal freeze-thaw cycles from September to May, with seasonal frost penetration to a few meters.

Results and discussion

A comparison between shattered bedrock, trapped debris, visual images and meteorological records showed that significant rockfalls and foot slope erosion occurred (1) during the night of 7-8 July, 2011 (precipitation ca. 30 mm) and (2) between 1 and 4 September 2011 when a large typhoon (precipitation 700 mm in total) crossed central Japan (see Figure). In addition, small, but continuous debris production seem to have dominated on the rockface during freeze-thaw and snowmelt periods. In normal years rockfalls prevail in freeze-thaw and snow-melt periods (Matsuoka 1990, Matsuoka & Sakai 1999), whereas the 2010-2011 period encountered an extraordinary and highly active debris production, partly responding to a heavy rain event.

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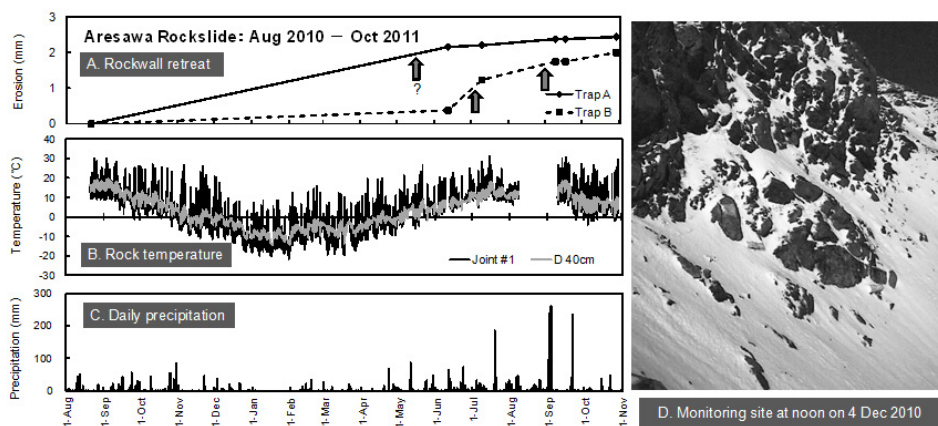
Figure: A. Rockwall retreat based on trapped debris. B. Rockwall temperature at surface and 40 cm depth. C. Daily precipitation. D. Snow condition at noon on 4 Dec 2011.

Keywords: rockfall, rock weathering, freeze-thaw, periglacial, monitoring, Japanese Alps

AHW28-P03

Room:Convention Hall

Time:May 20 17:00-18:00



Denudation rate of a large landslide in the Japanese Alps

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Akakuzure landslide, one of large landslides in the Japanese Alps, has an anacinal structure as a result of deep-seated gravitational slope deformation. Denudation rate of the bare ground in the landslide was evaluated from two kinds of geodetic surveys. The airborne LiDAR survey was performed for the whole landslide in 2003 and 2007. In contrast, the ground-based LiDAR was performed for the upper area of the landslide in October 2010, June and November 2011. In addition, meteorological parameters (air and ground surface temperatures and precipitation) were also monitored. The average denudation rate during 2003 to 2007 and during 2007 to 2010 indicated 0.22 m/yr and 0.18 m/yr, respectively. On one part, denudation rate during winter (October 2010 to June 2011) was about three times of that during summer (June to November 2011). Annual and diurnal frost actions probably cause such seasonal variation in denudation.

Keywords: LiDAR monitoring, frost action, gravitational deformation, denudation rate

Periglacial Environment around Mount Warusawa, Southern Japanese Alps

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Observations were carried out at Maru-yama station (3020 masl) from September 7th 2006 to August 31st 2008. The annual mean air temperature at the station in 2007 was -1.6°C . During this period, the normal value of the annual mean surface air temperature at Maru-yama was estimated to be -1.8°C . This was achieved by evaluating the normal values at Mt. Fuji meteorological station (3775 masl) of the Japan Meteorological Agency with a lapse rate of $0.6^{\circ}\text{C}/100\text{ m}$. Therefore, the climatic value of the annual mean air temperature at Maru-yama was estimated to be ca. -1.8°C .

The ground temperature of the north slope was lower than that of the south slope, and the ground temperature of the surface rubble layer at the north slope was the lowest.

The estimated normal value of the annual mean air temperature was very close to the threshold value (ca. -2°C) for the mountain permafrost distribution suggested by previous studies. And specific place in Maru-yama has a low-ground temperature possibility during the long period. Moreover, it is possible that some mountain permafrost conditions exist around the summit area of Maru-yama.

Keywords: Periglacial environment, Periglacial landform, Meteorological observation, Mountain Permafrost, Southern Japanese Alps

Spatial distribution of chemical components in snow layers at mountainous area, central Japan

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In mountainous area where less affected by human activities, we are able to collect efficiently chemical components in the snow layers, which is transported long-range from continent. In recent years, increase of acid material by the artificial source has been concerned. Although the studies about spatial distribution of chemical components have been executed actively on plain field and seacoast region, it is few in mountainous area of central Japan because of the difficulty of access. Therefore, it is significant to collect the data of chemical components in snow layers at mountainous area.

This study purposes of two things. First, we aim to clarify the origin of the chemical components preserved in snow layers on mountainous area of central Japan. Second, we discuss the spatial distribution of the chemical components in snow layers at mountainous area of central Japan.

We collected the samples of snow layers during February to April of 2011 in mountainous area of central Japan, and then we performed chemical analysis the samples using the ion chromatography.

In the results, it has become clear that the source of Na^+ , Mg^{2+} , and Cl^- are sea salt components. On the other hand, the source of SO_4^{2-} and NO_3^- are mainly non-sea salt components. Additionally, $\text{Na}^+/\text{Cation}$ and Cl^-/Anion are decreased with distance from the Sea of Japan. The opposite way round, $\text{nssSO}_4^{2-}/\text{Anion}$ (non-sea salt $\text{SO}_4^{2-}/\text{Anion}$) is increase with distance from the Sea of Japan.

Changing of snow chemistry in the Japanese Alps

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Various chemical materials were included in precipitation. Precipitated chemical materials have been stored in the snow layers before the start of snowmelt. Therefore, we get the atmospheric information in winter season from snowpack. We conducted the snow pit study, and the chemistry of snow layer was studied in detail. In this study, we aim to clarify characteristics of snow chemistry in the Japanese Alps. We conducted the sequential snow pit study during winter in Mt. Nisi-hodaka, the Japanese Alps. The snow pits were dug through the entire snowpack. We observed the cross-section of the snow pit to clarify snow conditions, which are snow stratigraphy, temperature, and density of snow. Afterwards we collected the snow samples. The snow samples were melted in a clean room. The pH and electric conductivity and concentrations of major ions were measured. Almost snow samples are acid snow (less than pH 5.62).

Spatial distribution of chemical components in fresh snow at the Japanese Alps

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The Japanese Alps area is one of the world's best snowy regions. In this area winter precipitation is observed mainly two patterns such as winter monsoon pattern and low pressure pattern. Therefore, the chemical characteristics of the snowpack are different by snowfall types. In order to understand hydro-chemical cycle of this area, it is important to evaluate the influence of snowfall. The purpose of this study was to clarify spatial distribution of chemical components in fresh snow. We conducted a snow pit study immediately after snowfall, on the route from Matsumoto to the city of Japan Sea side. Snow density and temperatures were measured every 0.03 m. After these measurements, we collected fresh snow samples. The samples were melted, then pH, electric conductivity and major ions (Na^+ , K^+ , Mg^{2+} , Ca^{2+} , Cl^- , NO_3^- and SO_4^{2-}) were analyzed in clean room. The concentrations of the sea salt components in fresh snow were lower at the inland observation point.

The regional and chemical characteristics of spring water in Kamikochi, the Japanese Alps

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There are much spring waters in the Azusa River which flows through Kamikochi. These spring waters form the branch of the Azusa River. Spring water shows the characteristics reflecting an underground water flow. Therefore, in order to understand the water cycle of Kamikochi, it is important to understand the formation mechanism of spring water. In this study, we aimed to clarify the characteristics of spring water which forms the branch of Azusa River in Kamikochi. We set up the thermometer in five places of a basin for the measuring of spring and river water temperature. The water samples were collected in water temperature measuring site and Azusa River from July 2011. The pH, electric conductivity and major ions were analyzed with the pH meter, conductivity meter, and ion chromatographs (Dionex: ICS-2000), respectively. In addition, HCO_3^- concentration was measured using the sulfuric acid titration method. The temperatures of spring waters were almost constant from the end of August to the beginning of October.

Nitrogen dynamics in two small watersheds with different stream nitrate concentrations

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Nitrogen dynamics were compared in two stream watersheds (#3 and #7) with different nitrate concentrations in their stream water. The nitrate concentration was always higher in the stream of #3 (1.6 mgN/L) than in that of #7 (0.3 mgN/L). Nitrogen deposition rate was higher in #7 than in #3, but nitrogen leaching rate at 40 cm below ground surface was higher in #3 than in #7. Increase in nitrogen isotope ratio of nitrate was observed in the bottom of the #7 watershed. Low plant uptake and immobilization by microorganisms with no clear denitrification in the #3 watershed might result in higher nitrate concentration in its stream.

Keywords: nitrogen dynamics, nitrate, stream, isotope ratio

Mapping of Stable Isotopes in Precipitation over the Japan Alps Area and Its Verification

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The isotope map serves as a useful tool for understanding movement, distribution pattern, and biogeochemical processes of water on the Earth, because the stable isotope ratios of water include information related to not only the processes of water cycle but also the cycle of various substances transported by water flow. However, the isotope map for the mountainous region cannot be easily made, because existing isotope data are very scarce in that region. Precipitation samples were collected at 14 points from July 2010 to June 2011 across the Japan Alps area and isotopic measurements of these samples were made to construct the isotope map. River water samples were collected at 45 points over the Fuji and Chikuma River basin. River water data are used by validation of the isotope map in precipitation. Correlations between $\delta^{18}\text{O}$ and altitude were significant through warm seasons whereas no significance was found in winter. Annual $\delta^{18}\text{O}$ in the Japan Alps area is controlled by altitude effect. The isotope map was created using the three interpolated methods which are (1) regression model by altitude as the explaining variable, (2) geostatistical model and (3) hybrid model. Validity of these models more different among the basins, suggesting different hydrological characteristics. In particular, downstream areas have higher $\delta^{18}\text{O}$ values in river water than in precipitation.

Keywords: Stable isotope, Japan Alps area, Altitude effect, Spatial distribution

Estimation of catchment transit time in Fuji River Basin by using an improved lumped model

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As an important parameter that reflects the characteristics of catchments, the catchment transit time (CTT) has been given much more widely attentions especially in recent years. The CTT is defined as the time water spends travelling through a catchment to the stream network ^[1], and it describes how catchments retain and release water and solutes and thus control geochemical and biogeochemical cycling and contamination persistence ^[2]. Conventional approaches for estimating CTT require specific hydrological characteristics such as transit time distribution (TTD) functions. The objectives of the present study are to develop a new approach for estimating CTT without prior information on such TTD functions and to apply it to the Fuji River basin in the Central Japan Alps Region.

In this study, an improved Tank model ^[3] was used to compute mean CTT and TTD functions simultaneously. It involved water fluxes and isotope mass balance. Water storage capacity in the catchment, which strongly affects CTT, is reflected in isotope mass balance more sensitively than in water fluxes. A model calibrated with observed discharge and isotope data is used for virtual age tracer computation to estimate CTT. This model does not only consider the hydrological data and physical process of the research area but also reflects the actual TTD with considering the geological condition, land use and the other catchment-hydrological conditions. For the calibration of the model, we used river discharge record obtained by the Ministry of Land, Infrastructure and Transportation, and are collecting isotope data of precipitation and river waters monthly or semi-weekly. Five sub-catchments (SC1~SC5) in the Fuji River basin was selected to test the model with five layers: the surface layer, upper-soil layer, lower-soil layer, groundwater aquifer layer and bedrock layer (Layer 1- Layer 5). The evaluation of the model output was assessed using Nash-Sutcliffe efficiency (NSE), root mean square error-observations standard deviation ratio (RSR), and percent bias (PBIAS) ^[4].

Using long time-series of discharge records for calibration, the simulated discharge basically satisfied requirements of reproducing water fluxes and their balance, while improvements in parameter estimations relating to isotope mass balance is necessary. The results of each sub-catchment demonstrated that the mean CTT of SC4 (1873 days = 5.13 years) is the longest among the other sub-catchments. However, the mean CTT of SC5 was estimated to be 316 days as the smallest one. The time of 6.78 years are required to renew 99.9% of the water volume in the SC5. The other sub-catchments need more than ten years to get 99.9% water volume refreshed. The estimated TTD functions demonstrate their dependence on precipitation amount and area of the catchment.

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Keywords: Catchment transit time, Tank model, isotope tracer, water flux

Snow Depth Measurement using Kinematic GPS on Karasawa Cirque, Japanese Northern Alps

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In the mountainous area, snow depth is known to increase so as to become of high altitudes. However, the snow depth distribution are hardly measured in the high mountain. It is significant to clarify the snow depth distribution based on actual measurement of snow depth in order to calculate the water equivalent of snow in its hydrographic basin. The measurement using GPS is attracted to attentions because the method of the GPS measurement is simple and high resolution. Especially, the Kinematic GPS measurement using two GPS receivers make possible to the measurement a wide area in a short time. We aim to measure the snow depth based on the Kinematic GPS measurement in Karasawa Cirque where is one of the biggest cirque in Japan.

Keywords: GPS, Kinematic measurement, Snow depth, Karasawa Cirque

A relationship between air temperature and shoot elongation of alpine dwarf pine at Mt. Kisokomagatake

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There are not any long time-series meteorological data around mountainous area in Japan, except for Mt. Fuji. However, it is possible to reconstruct climate in mountainous area in combination with various data.

This research was investigated that a relationship between monthly mean air temperature in July and shoot elongation of alpine dwarf pine at Mt. Kisokomagatake from 1980 to 2009. The result shows a positive correlation on the relationship, and indicates that data of shoot elongation of alpine dwarf pine can reconstruct summer air temperature. We will study climate reconstruction in mountainous area with tree width as a proxy data.

Keywords: mountainous area, air temperature, shoot elongation of alpine dwarf pine

Alpine vegetation monitoring using digital photography in the Kisokomagatake, central Japan

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The arctic and alpine floras are regarded as highly sensitive to the impacts of climate change. The climate changes will become increasingly pronounced over the next one hundred year. Therefore, we should accelerate our effort to assess and monitor trends in conditions of alpine vegetation to obtain early-warning signals of environmental change. However, most alpine regions are poorly monitored in Japan due to the harsh climate and difficult access.

We started the vegetation investigation at Mt. Koma and Mt. Sannosawa in central Japan. We also developed an automated green vegetation cover extraction methods using digital photography to simplify and accurately quantify the investigation. This study reported vegetation changes between 2008 and 2011.

We set 4 permanent quadrats of 1 m² at 14 sites on 6 regions and divided the each quadrat into 100 small grids (0.1 m²). All vascular plant species were recorded each grids. Percentage of green vegetation cover was calculated using digital photography of each quadrats as follows. The classification of green vegetation and background was achieved by determining a threshold in one-dimensional colour space, which is based on transform values ($G/(R + G + B)$) from RGB image. Soil surface temperature (at depth of 0.5-1 cm) was automatically recorded with data loggers at 1-h intervals to determine the timing of snowmelt.

Species richness per quadrats slightly increased during three years. Total number of emerged species in 100 small grids significantly increased. Vegetation cover also significantly increased in some quadrats. These results seem to be primarily caused by the recent warming in the region. Unusually high summer temperatures, which were 1.5 degrees higher than usual, have recorded in 2010. Vegetation cover of shrub species, such as *Pinus pumila*, increased in some quadrats. Because species richness tended to decrease at the quadrats that shrub species were dominant, species composition would be changed if these trends continue.

The results of this study suggest that changes in the vegetation cover will precede detectable changes in number of species and composition. The vegetation cover can be obtained by digital photography, which is more effective, objective, and accurate than human conducted methods.

It should be considered that short-term studies are not enough to resolve the uncertainty of whether recorded signals are consistent trends towards serious changes in numbers of species and composition. We will continue the monitoring to reveal longer term vegetation changes.

Keywords: vegetation monitoring, alpine plant, species richness, plant cover, digital photography

Marked loss of genetic diversity within glacial-relic populations of *Dryas octopetala* in the Japanese Alps

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For arctic-alpine species with wide-ranging distributions throughout circum-arctic regions and southward into mid-latitude mountains, range shifts in response to climatic change were both latitudinal (especially in circum-arctic areas) and altitudinal (in mountain regions). Latitudinal range shifts occurred over large areas and involved long-distance dispersal, whereas altitudinal shifts were more localized. Therefore, the genetic consequence of these types of range shift can be predicted to differ. *Dryas octopetala* L., an arctic-alpine plant, is widely distributed from the Eurasian and American arctic tundra to temperate mountains in Europe, in North America, and in Asia south to Japan, which is one of the southernmost areas for the cold-adapted species. In this study, we compared the genetic structure of *D. octopetala* populations along latitudinal transects from the High Arctic to mid-latitude mountains in the Japanese Alps. Investigation of genetic variation within *D. octopetala* populations inhabiting the Japanese Alps provides an example of how cold-adapted organisms survived at the southernmost limits of the distribution, at least since Holocene warming.

We analyzed a total of 656 individuals across 14 populations (six in the Japanese Alps, one in Hokkaido, one in China, three in North America, two in North Europe, one in the High Arctic) using nine nuclear microsatellite loci. Population genetic structure was assessed by analyzing genetic diversity indices for each population, examining clustering among populations.

The clustering analysis among the populations revealed an isolated marginal group of populations in the Japanese archipelago. The populations in the Japanese Alps exhibited low genetic diversity within populations compared with those in high latitude regions. Loss of genetic diversity was especially pronounced in the Southern Japanese Alps. High level of genetic diversity was detected in two Alaskan populations, supporting the Beringia refugium hypothesis for arctic and alpine plants. No significance of isolation-by-distance in the populations demonstrated that genetic drift was a strong force shaping the genetic structure in the Japanese Alps. The resulting stochastic reduction of genetic diversity in the cold-adapted plants at the southernmost limit of the distribution may constrain their evolutionary potential, thereby inhibiting adaptation under climate change.

Keywords: arctic-alpine plant, genetic diversity, genetic structure, glacial relic

Effects of gap-mosaic structures on biodegradation of organic matter in soil ecosystems in old-growth forest

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Old-growth forests serve as a global carbon sink, but they are not protected by international treaties, because it is generally thought that ageing forests cease to accumulate carbon in live woody tissues (Kira & Shidei 1967; Odum 1969). Recently studies reported however, old-growth forests can continue to accumulate carbon, contrary to the longstanding view that they are carbon neutral (Luyssaert et al. 2008; Lewis et al. 2009). If this is true, most of carbon may move into non-living pools such as litter (leaf and woody detritus) and soil. In addition, Old-growth forests generally have higher spatial heterogeneous structures (gap-mosaic structures). These forests structural properties may be greatly contributed to the carbon cycling of old-growth forests. In this study, we therefore focused on determining the litter decomposition rates and chemical properties of soil organic matter (SOM) in three stages of forest standings plots of old-growth forest to clarify the relationship between spatial heterogeneous and organic matter decomposition in surface soil ecosystems.

We conducted this study on Kayanodaira Research Station, Shinshu University, Japan (a permanent plot of 1 ha was set on a research station in 2005). The study area has a seasonal cool-temperate climate. The dominant species are *Fagus crenate* Blume (300~500 age). From November 2010, three experimental plots (15 m²) were established by differences of vegetation conditions to gap, young, and mature sites. Litter decomposition rate was estimated by litterbag methods from November 2010 to October 2011. Characterization of SOM was performed by optical properties. All investigation was performed 5 replicate.

Litter mass remaining rate during 350 days decreased from gap (86.8) > young (82.1) > mature (81.6) at L layer and decreased from gap (94.6) > young (89.0) > mature (85.5) at FH layers. Degree of biodegradation of SOM estimated from aliphaticity (Alkyl C:O-alkyl C ratio) in gap site showed significantly lower values. These results strongly suggest that gap structure slow the microbial activities in soil ecosystems in old-growth forest.

Ecophysiological dynamics of forest canopy photosynthesis and its optical observation

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Forest ecosystem has a crucial role in regulating the earth system as well as in supporting various ecosystem services such as primary production and biodiversity persistence. Understanding on the ecophysiological dynamics of forest canopy photosynthesis and ecosystem-scale carbon cycling is still an important theme of environmental science. In addition, the progress of satellite optical remote sensing provides us to observe the broad-scale ecosystem structure from days to years, and from plot to continental scales. In this study we aimed to reveal the functional role of leaf-level ecophysiology and forest leaf area distribution in forest canopy photosynthesis in a cool-temperate deciduous broadleaf forest at "Takayama" super-site, in central Japan. Simultaneously we made optical remote sensing of canopy structure in means of several vegetation indices (NDVI, EVI, GRVI, CI) to detect the phenological changes of canopy photosynthetic property. Our in-situ observation of leaf and canopy characteristics, which were analyzed by an ecosystem carbon cycling model, revealed that their phenological changes and summer micro-meteorology are responsible for seasonal and inter-annual variations in canopy photosynthesis. Significant correlations were found between the vegetation indices and canopy photosynthetic capacity, but the relationships changed throughout the seasons from spring to summer, and to autumn. Our next challenge goes to apply these findings to gain insights into detailed understanding on the carbon metabolism of forest ecosystem and also to assess the canopy photosynthesis at landscape - regional scales by satellite remote sensing.

Keywords: forest ecosystem, photosynthesis, ecophysiology, remote sensing

Carbon dynamics along a chronosequence of Japanese Cedar plantations in central Japan

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Managed, even-aged Japanese cedar plantations are now the most extensive managed forest ecosystem in Japan, comprising ~20% of the Japanese forested landscape. The age-dependent variability of ecosystem carbon dynamics was assessed by measuring biometric based net ecosystem production (NEP) of nine cedar plantations in Takayama, central Japan. The study sites ranged in age from 3 -year-old after plantation to mature stands (105 years). Total net primary production (NPP) was low immediately after plantation, highest 36 years stand, and then gradually decreased with age. In contrast, soil respiration had no clear trend with age, although root biomass related to soil respiration. After harvesting, cedar plantations are typically a net source of carbon around 5 years, followed by peak in NEP in mid-aged forest (ca. 40 years). In maturing stands, NEP declines as a result of the age-related reduction of growth.

Keywords: net ecosystem production, net primary production, soil respiration, cedar plantation, biometric, Takayama Forest

Carbon budget in a deciduous broad-leaved forest considering the expanded growing season length by global warming

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The growing season length of plants is one of the major interests in studying the current and future carbon cycles in terrestrial ecosystems, since it would directly affect the photosynthetic CO₂ uptake and respiratory CO₂ release in those ecosystems. In this study, we examined the possible effects of growing season length under current climate and in future climate on forest ecosystem CO₂ budget, by combining in-situ observation of canopy phenology and ecosystem carbon cycling model. First, by using daily canopy surface images and air temperature data at the Takayama deciduous broad-leaved forest site (TKY) from 2004 to 2009, we examined the dates of the beginning of leaf expansion, the beginning of autumn leaf color development, and the end of leaf-fall, and their relationships with air temperature. We found that (1) leaf expansion began when the accumulated effective air temperature from the first day of the year (based on a 5 deg C threshold) exceeded 140.0 +/- 13.5 deg C (average +/- standard deviation) during spring; (2) leaf color development began when the 5-day moving-average daily temperature fell below 10.8 +/- 1.3 deg C during autumn; and (3) the leaf-fall period, which was defined as the period between the beginning of autumn leaf color development and the end of leaf-fall, was 30.7 +/- 4.0 days. Second, we adapted these relationships between leaf phenology and air temperature to account for the seasonal variation of leaf area index (LAI) under future climatic conditions referring to the projection data of climatic conditions based on several scenarios from CMIP3 Multi-Climatic Models. As a result, the growing season length was expected to expand in future climate than present. Finally, we introduced thus simulated phenology of LAI into NCAR/LSM model to examine its possible effects on canopy photosynthesis, ecosystem respiration and resulting net ecosystem CO₂ budget in the future climate. Our analysis could provide the importance of phenological field observation and the consideration of phenological impact for future climate studies.

Keywords: Carbon budget, Cool-temperate, Deciduous broad-leaved forest, Future climate scenarios, Phenology

Recent changes in the genetic structure of the Asian black bear *Ursus t. japonicus* in the Japanese Alps region

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Asian black bear *Ursus thibetanus* habitats are dotted intermittently across South and East Asia. They have been divided into seven subspecies. In Japan, the subspecies *U. t. japonicus* inhabits two of the main islands, Honshu and Shikoku. It is considered that the population of Kyushu is extinct. The Japanese Alps region is one of the most significant habitats for the Japanese black bears, since it provides a habitat, which is largely contiguous and as such their density is very high. The black bear is omnivorous, but they mainly rely upon a herbivorous diet plant-origin foods. In particular in late autumn before hibernation, it is estimated that they have to consume food amounting to ca. 5500kcal per day (per individual of 60kg bear). Their main food is a kind of beechnut, which are the also-called "acorns". As such, during years when the beech species provides a poor yield of nuts, many of the black bears come down to areas of human habitation in search of sufficient food to prepare for hibernation. In such years, damage to crops and attacks on humans by bears increase, so as a result a larger number of bears will be killed as a pest control under the "prefectural wildlife conservation and management plan". Nagano Prefecture carried out to estimation of the number of individual of black bears, it has also set an upper limit of ca. 150 on the maximum number of individuals that can be killed each year. Since then, a report the Wildlife Conservation and Management Program of Nagano Prefecture recently estimated that the number of black bear habiting Nagano Prefecture has increased significantly in this decade; 1913 individuals in 2001, 2771 in 2006 and 3624 in 2011. However, during in this decade, in 2006 and 2010, the number of bears killed has unfortunately exceeded the upper limit set, as higher population has resulted in a higher incidence of conflict with humans; 558 individuals in 2006 and 361 in 2010. In this present study, we have performed genetic analyses, in order to understand in more detail the population and genetic structures of black bears in the Japanese Alps and around the surrounding regions,. We analyzed 625-based sequences in the D-loop region of mitochondrial DNA using approximately 100 samples collected from diverse locations across Nagano Prefecture. We compared our analyzed data with the data of several previous analyses (Ohnishi et al., 2007, 2009), and also an impact assessment was carried out into the higher killing rate of recent years; i.e., we evaluated whether any effect of genetic bottleneck was resulting or not. As a result, the genetic diversity of black bears in Nagano Prefecture was found to be much higher than the previously evaluated; the haplotype diversity (Hd) found in this study was 0.679, and the nucleotide diversity (Pi) was 0.0031, whereas in Ohnishi et al. (2009), Hd=0.4734, Pi=0.0012. Of particular note, it was revealed that the genetic diversity observed amongst the northern bear populations was clearly higher, whilst the genetic diversity was comparatively low amongst the southern bear populations. Based upon the analysis of molecular variance (AMOVA), it was revealed that gene flow of black bears was significantly restricted between three identifiable regions of Nagano Prefecture; i.e., the northern, central and southern regions. This localized genetic population level data for the Japanese Alps and surrounding areas will be utilized in the formulation of future protection and management planning and policy.

Chemical mimicry of an aphid to mutualistic ants

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Ant-aphid interaction is one of the most famous examples of mutualism in which ants attend aphids for their honeydew and protect them against enemies. However, ants also often hunt the aphids they attend. To explain the proximate factor causing ants' hunting behavior, Sakata (1994) proposed "marking hypothesis" which posits that ants mark something to the aphids providing ample honeydew and the nestmate ants tend to hunt those aphids with less marks (providing less honeydew). Recently, Endo and Itino (in press) found that the ants' cuticular hydrocarbons (CHCs), which are ants' nestmate recognition signals, work as the real marking substances in the *Stomaphis-Lasius* system.

Thus aphid needs to provide much honeydew to avoid ant's predation, however it is costly to produce much honeydew. Therefore, aphid may use chemical mimicry, which is used in many insects parasitic to ants, as an alternative strategy to avoid ant's predation.

Based on the fact that the CHCs work as marks, we hypothesize that the aphids mimic chemically to the ants' CHCs as a counter-adaptation against the ants' predation using CHC marks. To elucidate the resemblance of the aphids' and ants' CHCs in non-contact conditions, we reared the aphid *Stomaphis yanonis* in the absence of attending ants, analyzed their CHCs by GC-MS, and compared their CHC profiles with the attending ants' in the wild. We found that the CHC profiles of the non-ant-attended aphids (Figure (c)) resemble those of the mutualistic *Lasius fuji* ants (Figure (a)). This suggests that the aphids mimic chemically to the ants' CHCs.

Keywords: ant-aphid mutualism, chemical mimicry, cuticular hydrocarbons (CHC), *Lasius fuji*, *Stomaphis yanonis*

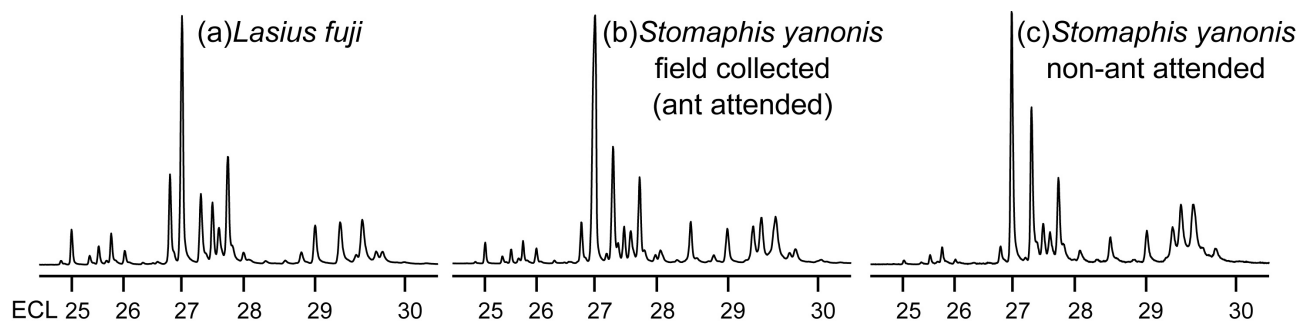


Figure Cuticular hydrocarbon profiles of (a) the ant *Lasius fuji*, (b) the aphid *Stomaphis yanonis* (field collected), and (c) *S. yanonis* (non-ant attended).

Flower size variation along altitude and gene flow of *Campanula punctata*

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Abiotic environmental changes along altitude influence plant distribution and character variation. In some plants, altitudinal decrease of plant size is known as a genetic structural change in response to climatic change. Flower size variation may also be influenced by these abiotic factors. On the other hand, geographic variations of flower size have often been reported to reflect selection pressure by regional pollinator fauna. This suggests that flower size may change altitudinally in response to the size of pollinators.

Campanula punctata var. *hondoensis* is distributed over a broad altitudinal range, and their pollinator composition is known to be different along altitude. Thus, the selection pressure by pollinators may differ among altitudes.

Here, we investigate the pollinator fauna, flower size variation and gene flow along altitudinal gradient and found that 1. the composition of *Bombus* pollinators changes along altitude, 2. the flowers are basically smaller in higher altitudes while plant height or the number of flowers per plant does not change along altitude, 3. the flower size along altitudinal gradient correlates closely with pollinator size, 4. microsatellite analyses suggest no genetic differentiation along altitude.

These results suggest that flower size variation along altitude is influenced by the pollinators' selection pressure, and is maintained even in the presence of gene flow.

Keywords: flower size, pollinator, gene flow, altitude, natural selection

The complex evolutionary history of the acquisition of morphological polymorphism in *Panorpodes paradoxus*

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The panorpidid scorpionfly *Panorpodes paradoxus* (Panorpididae), which inhabits mountainous areas has many varied types of body color and wing spots pattern. In addition, it has known that female of *P. paradoxus*, which are living in the high altitude regions of the Central Japan and the several mountains of Tohoku (Aomori Prefecture), have short wings and these are called "short-winged type". Furthermore, the short-winged type has many morphological differences from "long-winged type"; (1) male's antenna is longer than that of long-winged one, (2) upper ridge of the hypandrium is rounder than long-winged one, (3) female's body color is dark brown (long-winged type's body color is generally pale yellowish brown), (4) female's wing spots pattern is characteristic and differ from long-winged one (there are many long-winged females which have not any wing spots, but short-winged female always has wing spots), (5) male of short-winged type has faint wing spots (appearance of wing spot is very rare in long-winged male), therefore, it is referred that "short-winged type" is an adaptation to high mountains, and suggested that "short-winged type" is a different species from "long-winged type" (Ichida, 1990).

So, in this study, we performed molecular phylogenetic analyses in order to confirm whether there are genetic differences between *P. paradoxus* of long- and short-winged types, together with this species having other varied morphological characteristics, or not. As a result, the long- and short-winged types did not separately compose monophyletic groups, and many varied types of body color and wing spots pattern did not related to the phylogenetic relationship. Furthermore, long-winged and short-winged populations occurring in the same mountain each composed monophyletic groups, but the two populations were never monophyletic.

Our phylogenetic analyses revealed that the many varied morphological types of *P. paradoxus* have complex evolutionary history. Although this species has varied wing length types, almost of mecopteran insects generally have long wings, consequently it is inferred that the short-winged type is the derivative character. The short-winged type differentiated in polyphyletic, and female of this type is darker in body color than long-winged type, and always has wing spots, and this derivative type is observed at high mountain regions. So it is possibly to refer that the short-winged type is the "ecomorph" in this species adapting to coldness, strong wind and ultraviolet radiation.