

Are habitats such as fumaroles or areas with heavy snowfall suitable for organisms living in Yuzawa Geopark? Considering the efficacy of the Geopark Guides with a focus on Yamatanukiran and snow camellia.

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Outline

The biodiversity of Yuzawa Geopark is derived from its unique geodiversity, which includes abundant geothermal activity and heavy snowfall. For example, almost no organisms can persist in the vicinity of the Kawaragejigoku-fumarole, which is a geofeature formed by geothermal activity, snow, and rain water, due to the effect of hydrogen sulfide gas. One exception is the dominant and rare species Yamatanukiran (*Carex angustisquama*). The heavy snowfall in the geopark affects the distribution of snow camellia (*Camellia rusticana*), which has supple branches than can withstand heavy snows. In general, Yamatanukiran and snow camellia are found in acidic soils, such as those located near fumaroles (Tsumimura 1982), or along the land of the Japan Sea side (Sakai 1977). The distributions of these two species reflect key characteristics of this unique region.

Typically, two primary reasons are cited for the observed distributions of these two species: 1) that these species merely prefer these environments and/or 2) that their growth is adapted only to this environment. However, we suspect that such explanations are flawed and/or lack a solid foundation. At first glance, the growth of the two species appears to be adequate at their current locations. Neither species requires the existence of fumaroles or heavy snow, given that Yamatanukiran thrives in agricultural soils (Yuzawa Municipal Sukawa Junior High School, 2011) and that snow camellia is bred at botanical gardens on the Pacific side of Japan (e.g., Koishikawa Botanical Garden, 2019). Yuzawa Municipal Sukawa Junior High School (2011) suggested that the growth rate of Yamatanukiran improves as pH approaches neutrality, and as the distance between individual plants and fumaroles increases. In other words, the influence of soil acidification near fumaroles does not promote the growth of Yamatanukiran but instead inhibits it. Therefore, the fumarole has an overall negative effect on the success of Yamatanukiran. Regarding snow camellia, this species almost certainly experiences damage from avalanches or heavy snow. Based on the above information, we concluded that the restricted distributions of these two species represent their response to strong negative effects rather than being a consequence of fumarole and heavy snowfall environments.

Clearly, in the geopark, as-yet-unknown factors have relegated the two species to inadequate environments.

We refer to plausible reproductive interference [interspecific interactions between closely related species (Takakura and Nishida 2018), e.g., *C. angustisquama* with the widely distributed species, *Carex podogyna* (Fujiwara 1997); and *C. rusticana* with a species found along the land of Pacific side of Japan, *Camellia japonica* (Sakai 1977)] as the primary factor limiting the biodistribution of the two species, as well as to problems with the academic credibility of the Geopark Guides.

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