Contribution of Buried Seeds to Revegetation after Eruptions of the Volcano Usu, Northern Japan

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Soon after the 1977-78 eruptions of the volcano Usu, there were created many gullies in which former topsoil, i.e., well-developed soil accumulated before the eruptions, was eroded in the crater basin, whereas the outside of the gully was covered with thick volcanic deposits. The short-dispersal-seed plants were the most abundant in the inside of gully where the former topsoil was exposed, however, they have not immigrated from external environments. The germination tests of the seeds extracted from the former topsoil demonstrated that viable seeds were buried at 1683.3/m² for 9 years after the eruptions. At least, 12 herbaceous species, e.g., *Rumex obtusifolius*, *Geum macrophyllum* var. *sachalinense* and *Poa annua*, were derived from the buried seeds in the former topsoil. Their contribution to revegetation was estimated to be 40.0% in the inside of gully where the former topsoil was exposed in 1983, suggesting that buried seeds are one of the most important seed source for revegetation even in the case of a volcano which produced pumice and ash by eruption.

Key words: Buried seed — Former topsoil — Revegetation — Seed longevity — Usu — Volcanic deposits.

Seeds of some plants are kept in a dormant state in the soil (Grime, 1979) and they occasionally contribute to the establishment of plant communities, such as pastures (Chippindale and Milton, 1934; Champness and Morris, 1948), farms (Brenchley and Warington, 1930), marshes (van der Valk, 1978), and natural forests (Nakagoshi, 1985). The longevity of buried seeds has not been accurately determined in most field studies (Priestley, 1986), though the adaptive and evolutionary implications of the buried-viable seeds have been discussed in various plant species (Harper, 1977).

The volcano Usu in southern Hokkaido (42°33’N, 140°50’E) is one of the most active volcanoes in Japan. Before the latest eruptions of 1977 and 1978, the vegetation of this volcano had been dominated by *Populus maximowiczii* and *Betula platyphylla* var. *japonica*, and partly by meadows consisting of *Trifolium repens*, *T. pratense*, *Dactylis glomerata*, etc. (Tsuyuzaki, 1987). At the eruptions, the summit area was completely deforested by a 1–3 m accumulation of volcanic deposits consisting of ash and pumice (Niida et al., 1980). The present research provides the evidence of viable seeds buried under the thick cover of volcanic deposits and their contribution to early volcanic succession.
Study Area and Methods

Revegetation was most conspicuous in the north-eastern region of the summit area in 1983. This area was constructed of a crater basin surrounded with a caldera rim and the NW slope of O-Usu. In this area, plant communities were dominated by *Polygonum sachalinense*, *Petasites japonicus* var. *giganteus*, *Aster ageratoides* var. *ovatus*, *Aralia cordata*, etc. which recovered by vegetative reproduction soon after the eruptions (Tsuyuzaki, 1987). The habitats were divided into three types, EG, CG and OG, as reported elsewhere (Tsuyuzaki, 1989). EG was the inside of gully where the former topsoil is exposed. In the present paper, the former topsoil means the well-developed soil, which was accumulated before the 1977-78 eruptions, covered with thick volcanic deposits. Soil movements occurred frequently in EG, hence, the former topsoil eroded in the upper reaches of the gullies, and deposited in the lower of them. CG was the inside of gully where the former topsoil is still covered with the volcanic deposits. Although the soil movement occurred, the former topsoil was covered with thick volcanic deposits. OG was the outside of a gully. Soil movement occurred only slightly and thick volcanic deposits were still overlaid upon the former topsoil.

In 1983, vegetation surveys were undertaken in twenty-one 2 m × 5 m quadrats established along two gullies. Out of these quadrats, 10 quadrats were located at OG, 7 were at EG, and 4 were at CG. In 7 pairs of 14 quadrats established both outside and inside the gully, the elevation was decreased from Quadrats 1-7. In Quadrats 1-6, the exposed former topsoils were partly flushed out by rain and snowmelt, and deposited at the lower part of the gully, Quadrat 7. In each quadrat, the number of individuals were counted for each species.

To determine habitat differences of each species, distribution pattern of each species in the study area was examined based on inter-group difference among three habitats determined by Kruskal-Wallis test (Ishii, 1975) and frequency of appearance with each habitats. The seed-dispersal type of each species was estimated according to Numata and Asano (1969).

To examine the existence of viable seeds in the former topsoil, a germination test was carried out in October, 1984. Eight soil samples of three liters were collected at different sites, of which four were from the volcanic deposits and another four were from the former-topsoil layer. Each soil sample was divided into three one-liter portions and two of them were chilled in the dark under the following different conditions prior to the supplying of water, i.e., 4 °C for 3 days and 25 days, respectively, while remainder was used as a control. Those soil samples were spread over wetted vermiculite and subjected to a germination test at room temperature and a 16-hr light period for 3 months until no more seeds germinated.

In 1987, buried seeds were extracted by a flotation method as reported previously by which most of the seeds could be recovered from various soils (Tsuyuzaki, in press). For this experiment, six blocks of former topsoil were collected under 65- to 140 cm thick volcanic deposits. The extracted species were identified by germination tests.