The impact of trampling by tourists on a high altitudinal grassland in the Tyrolean Alps, Austria*

G. Grabherr**

Institut für Botanik der Universität Innsbruck, A-6020 Innsbruck, Austria

Keywords: Austria, Disturbance, High altitudinal grassland, Trampling impact

Abstract

The long term effect of tourist trampling on a high altitudinal grassland (Caricion curvulae) in the Tyrolean Alps was investigated.

Even under slight trampling the frequency of sensitive species decreases. The most sensitive species were found to be fruticose lichens, followed by mosses, some forbs and broadleaved grasses. Tolerant to trampling are the dominant species Carex curvula, and Ligusticum mutellina, which do not disappear completely even at a tourist frequency of 150 tourists per metre per day. Trampling increases soil bulk density moderately but has no marked effect on the soil water content.

Comparison with high alpine sedge heath vegetation in North America shows a surprising uniformity of this vegetation type in response to trampling and also indicates that the common generalisation that alpine ecosystems are fragile and sensitive to disturbance does not hold true in this context. Furthermore these results represent evidence against the theory that ecosystems with low diversity are much more sensitive to arteficial impact than ecosystems with high diversity. However, if even the most resistant plants which are the dominant sedges are destroyed completely the rate of recovery is very low and may last for a long time. In the case of Carex curvula this is supported by the fact that it has very low seed production and grows mainly vegetatively. The rate of spread of the rhizome system of this species is 8 mm in 10 years. Similar figures may apply for the sedge species dominating in the alpine vegetation of North America. Thus fragility of this vegetation in regard to trampling does not mean low tolerance but low regeneration.

Introduction

The trampled vegetation at footpaths, gateways, hedgerows and badly maintained sports grounds as a special type of plant community attracted the interest of botanists quite early, and has been investigated from several points of view. The results have recently been summarized by Ellenberg (1978) for Central Europe and Liddle (1975) for Western Europe. But as the touristic pressure in recreation areas has greatly increased during the last two decades, trampling has had a severe impact on vegetation types which had been nearly or completely free of any human influence in the past, for example, sand dunes (cf. Liddle & Greig-Smith, 1975a, b; Blom, 1976, 1977; Boorman & Fuller, 1977), forests (cf. Falinski, 1975; Kellomaeki & Saastamoinen 1975, Dale & Weaver, 1974; Arrighetti et al., 1977), mountainous areas (cf. McQuaid-Cook, 1978; Bell & Bliss, 1973; Willard & Marr, 1969, 1970; Cole, 1978; Bayfield, 1971; Körner, 1980; Lippert, 1972).
In the Alps high tourist concentration occurs particularly in the vicinity of the top station of cable cars and in the adjacent areas. As in the vegetation listed above the following questions arise: What intensity of trampling pressure changes the natural vegetation slightly, what intensity destroys it completely? What is the nature of this change? Are there species which show some increase in, or even invade these areas, or is the only effect of trampling a decrease in number and frequency of species? If so, do all the species react in the same way? To answer these questions for a high altitudinal grassland in the Alps an investigation was carried out in a Carex curvula dominated sward (Caricion curvulae) near Obergurgl, Tyrol. It formed part of the Austrian MAB-project.

Research area and vegetation

The village of Obergurgl (45° 52' lat., 10° 20' lon.) is situated at the end of the Tyrolean Oetztal (Austria) at an altitude of 1930 m a.s.l. This area belongs to the old crystalline rocks of the Oetztal mass and is characterized by a continental climate typical of this part of the Eastern Alps (Table I). One third of the whole area is covered by a vegetation which consists of 70% of alpine grassland, 15% of alpine dwarf shrub heath, 10% of forests and Krummholz, and 5% of agricultural land. The alpine grassland includes several plant community types but the most common one is a dense, lichen-rich sward dominated by Carex curvula (Caricion curvulae in the context of the Braun-Blanquet approach). A list of species may include: Avenochloa versicolor, Oreochloa disticha, Festuca halleri, Tanacetum alpinum, Leontodon helveticus, Phytheuma hemisphaericum, Ligusticum mutellina, Veronica bellidoides, Primula glutinosa.

The investigations were carried out at the so-called Hohe Mut area which is a southeast-northwest oriented, gently sloping ridge at 2,560 – 2,650 m a.s.l. It is covered nearly completely with a Carex curvula sward, with some patches of snow bed vegetation interspersed. At one end a cable car carries tourists in large numbers to the area (up to 50,000 per summer). They disperse in the direction of the ridge concentrating on one main path but also wandering from it extensively. Thus in some parts less well defined tracks have been established in the period of more than 20 years that the lift has been operating.

Methods

For the investigation of trampling on the vegetation two different methodological approaches have been elaborated (cf. Liddle, 1975). The traditional one is to investigate species composition, the amount of these species, trampling intensity and the variation of some relevant ecological factors along a transect perpendicular to the path. The endpoints of the transects are the most trampled and the untrampled vegetation. This method gives sufficient results if trampling has been of occurrence for a long period. It assumes that the species composition and amounts along the transect are stable as long as there is no change in the temporal and spatial trampling pattern. Classical descriptions of trampling vegetation on foot paths, gate ways (Polygonion avicularis in the sense of the Braun-Blanquet approach) were based in principle on this method (cf. Bates, 1935, 1937; Davies, 1938). Recently it was used by Cole (1978) and Crawford & Liddle (1977). But in most of the numerous recent investigations the disturbance effect has lasted for a period which is too short to establish a stable situation. In this case trampling experiments have been widely used from which the initial effect can be demonstrated. From this type of investigation an approximate prediction of the long-term effect may be possible. The cable car to the Hohe Mut area was built in 1955. Thus trampling has had an influence for a comparatively long time during which the development of a stable situation on the tracks and to either side of the path can be assumed. Consequently a realistic estimation of the long term effect seemed to be possible and the transect method to be applicable.

Table I. Climate of Obergurgl (1953–1960) (summarized by E. Winkler; from Moser 1975).

| Duration of sunshine per year | 768 h |
| Days with precipitation per year | 167 d |
| Precipitation (annual) | 827 mm |
| Air temperature (annual) | 2.2 °C |
| Air temperature (July mean) | 9.9 °C |
| Air temperature (January mean) | -6.3 °C |