Notes and records

Fire-induced reproduction of *Festuca pilgeri* in the subalpine zone of Mount Kenya

Truman P. Young

Department of Environmental Horticulture, University of California, Davis, CA 95616, U.S.A.

Introduction

Plant species in fire-dominated habitats are characterized by a variety of evolutionary adaptations to fire (reviewed in Gill, 1981; Bond & van Wilgen, 1996). These include thick bark, the ability to coppice, and protected meristems, such as those in tussock grasses. The reproductive opportunities created by fire favour adaptations such as fire-induced reproduction (Gill & Ingwersen, 1976; Le Maitre & Brown, 1992; Verboom, Stock & Linder, 2002) and dormancy that is broken by smoke (Keely, 1993) or intense heat.

Fire appears to be common in the sub-alpine shrublands and grasslands of the tropics (Hedberg, 1964; Beck, Scheibe & Schulze, 1986; Lægaard, 1992; Young, 1996). On East African mountains, as elsewhere in the tropics, the sub-alpine zone is characterized by ericaceous vegetation floristically and physiognomically similar to fire-prone chaparral biomes (Young, 1991, 1996; Safford, 2001). The woody species there readily coppice after fire (T. Young, pers. obs.; Hemp & Beck, 2001). The ericaceous zone of Mount Kenya burned several times between 1970 and 1990 at different sites (Young, 1996; Phil Snyder, Bill Woodley & Bongo Woodley, pers. comm.). Each of these fires covered several hundred hectares. As yet we have no data on return intervals but many of these fires are suspected to be human-caused by honey hunters (Phil Snyder & Bill Woodley, pers. comm.).

Festuca pilgeri St-Yves is the dominant grass in the alpine zone of Mount Kenya, forming nearly monospecific stands in some areas (Hedberg, 1964, Young & Peacock 1992). It forms dense tussocks up to 50 cm in diameter. It occurs in both reproductive and mostly sterile populations on Mount Kenya, with the latter predominating at lower elevations in the subalpine zone (Young & Peacock, 1992).

Study site and methods

This research was carried out in June 1980 on the north-western slopes of Mount Kenya at an elevation of 3300 m, along the Timau Track, an unimproved vehicle track. A fire had occurred at the site 6 months previously (January/February; Phil Snyder, pers. comm.), and the track had served as a firebreak. The area north of the road had burned, and the area south of the road had not.

On 29 June, I carried out a survey of tussock density and reproduction in *F. pilgeri* at this site. I laid out six paired 30×2 m line transects, three on the burned side of the road, and three on the unburned side. Along each transect, I counted the total number of *F. pilgeri* tussocks, and the number of these that had reproductive culms. I surveyed a total of 668 individuals. The densities of tussocks and the per cent reproductive tussocks in the burnt and unburnt areas were compared in simple *t*-tests, with a sample size of three.

Results and discussion

The average density of *F. pilgeri* tussocks was similar in the burned and unburned areas (mean number per $m^2 \pm 1$ SE: 1.84 ± 0.07 versus 1.87 ± 0.04, $t = 0.32$, $P = 0.77$). In the three transects in the unburned area, only one tussock of 336 was reproductive. In the three transects in the burned area, 92% of the tussocks were reproductive (306 of 332). This difference was statistically significant ($t = 62.01$, $P < 0.0001$).

The similar densities of *F. pilgeri* tussocks in the burned and unburned areas suggest that this species suffered essentially no adult mortality in the fire, and is fire-tolerant (see also Hedberg, 1964, Fig. 22). The virtual absence of reproduction in unburned areas, contrasted with over 90% flowering in the burned areas, suggests that some populations of *F. pilgeri* may be dependent on fire for recruitment. Together, these results suggest a long evolutionary exposure of this species to fire. To our knowledge, this is

Author's address: E-mail: tpyoung@ucdavis.edu

the first demonstration of fire-induced reproduction from a tropical alpine ecosystem.

Fire-induced reproduction appears to be more common in nutrient-poor habitats, and it has been suggested that the effects of fire are limited to the release of limiting nutrients (Verboom *et al.*, 2002). However, the nutrient-rich volcanic soils of Mount Kenya (Young, 1984) imply other proximate cues, such as increased light or soil moisture availability. A likely evolutionary reason for this fire-induced reproduction may be the opening of rare sites for seedlings after a fire.

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References

Beck, E., Scheibe, R. & Schulze, E.-D. (1986) Recovery from fire: observations in the alpine vegetation of western Mt. Kilimanjaro (Tanzania). *Phytocoenologia* **14,** 55–77.

Bond, W.J. & van Wilgen, B.W. (1996) Fire and plants. Chapman and Hall, London, England.

Gill, A.M. (1981) Fire adaptive traits of vascular plants. In: *Fire regimes and ecosystem properties* (Eds H. A. Mooney, T. M. Bonnicksen, N. L. Christensen, J. E. Lotan and W. A. Reiners). USDA For. Serv. Gen. Tech. Rep. WO-26, Washington, DC, pp. 208–230.

Gill, A.M. & Ingwersen, F. (1976) Growth of *Xanthorrhoea australis* R. Br. in relation to fire. *J. Appl. Ecol.* **13,** 195–203.

Hedberg, O. (1964) Features of afroalpine plant ecology. *Acta Phytogeographica Suecica* **49,** 1–14.

Hemp, A. & Beck, E. (2001) *Erica excelsa* as a fire-tolerating component of Mt Kilimanjaro's forests. *Phytocoenologia* **31,** 449–475.

Keely, J.E. (1993) Smoke-induced flowering in the fire-lily *Cyrtanthus ventricosus*. *S. Afr. J. Bot.* **59,** 638.

Lægaard, S. (1992) Influence of fire in the grass páramo vegetation of Ecuador. In: *Páramo. An Andean ecosystem under human influence*. (Eds H. Balslev and J. L. Luteyn). Academic Press, London, England, pp. 45–60.

Le Maitre, D.C. & Brown, P.J. (1992) Life cycles and fire-stimulated flowering in geophytes. In: *Fire in South African Mountain Fynbos* (Eds B. W. van Wilgen, D.M. Richardson, F.J. Kruger and H. J. van Hensbergen). Springer-Verlag, Berlin, pp. 145–160.

Safford, H.D. (2001) Brazilian paramos. III. Patterns and rates of postfire regeneration in the campos de altitude. *Biotropica* **33,** 282–302.

Verboom, G.A., Stock, W.D. & Linder, H.P. (2002) Determinants of postfire flowering in the geophytic grass *Ehrharta capensis*. *Funct. Ecol.* **16,** 705–713.

Young, T.P. (1984) Comparative demography of semelparous *Lobelia telekii* and iteroparous *Lobelia keniensis* on Mount Kenya. *J. Ecol.* **72,** 637–650.

Young, T.P. (1991) The flora, fauna, and ecology of Mount Kenya and Kilimanjaro. In: *Guide to Mount Kenya and Kilimanjaro* (4th edn.) (Ed. I. A. Allen). Mountain Club of Kenya, pp. 37–49.

Young, T.P. (1996) High mountain and afroalpine ecosystems. In: *Ecosystems of East Africa and their Conservation* (Eds T. R. McClanahan and T. P. Young). Oxford University Press, New York, pp. 401–424.

Young, T.P. & Peacock, M.M. (1992) Giant senecios and the alpine vegetation of Mount Kenya. *J. Ecol.* **80,** 141–148.