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Predation by elephants (*Loxodonta africana*) on *Senecio keniodendron* R. E. Fr. & Th. Fr. Jr (Compositae), a caulescent giant rosette species common above treeline on Mount Kenya, is altering the physiognomy of the alpine plant community in some sites. This is causing a shift from open-canopied "alpine woodland" to grassland. This interaction raises questions concerning the physiology and foraging behavior of elephants (Laws *et al.* 1975) and the responses of comparatively simple tropical plant communities to perturbation (cf. Good 1968, Vesey-Fitzgerald 1973, Dayton 1975, Pinder 1975, Allen and Forman 1976, Connell 1978). In this paper, we summarize the extent of the interaction and discuss its implications.

Senecio keniodendron is endemic to the alpine zone of Mount Kenya, and occurs between 3700 m and 4500 m elevation (Hedberg 1964, Coe 1967). The woody stem grows to 8 m tall; estimates of stem growth rates range from 1 to 5 cm per year (Hedberg 1969, Smith and Young unpubl. data). Flowering is synchronous throughout the population and occurs at intervals of 5 to 29 years (Smith and Young 1982). It forms open-canopied stands on well-drained slopes, with ground cover of herbs, grasses, and prostrate shrubs.

Between May 1977 and April 1978 we noted the destruction of 53 of 60 permanently marked adult *S. keniodendron* plants in two study plots at 3800 m in Teleki Valley. Trunks generally were split open and portions of the central pith were removed. Fresh elephant droppings and footprints were associated with this mortality. Wind-thrown plants are not split open, and other animals, including man, are not strong enough to knock over and split open mature *S. keniodendron* plants. Very extensive elephant damage to *S. keniodendron* was seen in Liki North Valley at and below 4100 m in May 1977. In 1977 Smith observed elephants in this valley, and in 1979 Young saw them feeding on *S. keniodendron* in Teleki Valley. The Liki North mortality also was noted in 1975 (V. Fayad, pers. comm.).

No earlier records apparently exist of elephants feeding on *Senecio* on Mount Kenya or elsewhere. However, the localized nature of the feeding and the scarcity of extended scientific field work on the mountain make negative evidence of limited value. Elephants were observed above treeline on Mount Kenya in the early 1950's (R. K. Nabea, pers. comm.) and probably visited alpine regions earlier than this, as evidenced by a weathered elephant skeleton above 4400 m elevation on Mount Kenya, first noted in the late 1940's (B. Woodley, pers. comm.). M. J. Coe (pers. comm.) noted no elephant damage to *S. keniodendron* in Teleki Valley in 1957. A similar elephant feeding pattern was noted by Smith for *Senecio erici-rosenii,* above treeline on Mount Karisimbi, Virunga Volcanoes, Zaire, in April 1979. Feeding there occurred between treeline and 3900 m.

During 1980 and 1981 we conducted a survey of Mount Kenya to determine the extent of elephant predation on *S. keniodendron.* Methods included (1) surveys by aircraft; (2) an elevational transect between 3800 and 4200 m in Teleki Valley documenting the total number of individuals affected by elephant predation in areas between landmarks located on a topographic map; (3) surveys in Teleki Valley of permanently marked transects, each 4 m wide and 30 m long, in sites with elephant-damaged *Senecio* and in topographically similar sites lacking evidence of elephant feeding; and (4) visits on foot to other valleys. For transects through damaged and undamaged sites we distinguished between two size classes of individuals: plants with stems tall enough to raise live rosette leaves off the ground, and those shorter than this. Individuals in the latter category were always prereproductive and are hereafter referred to as juveniles. Elephants split the trunks with the long axis of the stem and ignored the foliage, producing a distinctive pattern of damage recognizable from the air with binoculars as well as on the ground (Fig. 1). Elephant droppings and footprints were always found in association with the damage during ground surveys.

Surveys from the air and on foot showed that at least 6 of the mountain's 11 major valleys had recent elephant predation on *S. keniodendron.* Recently damaged plants still had green leaves on several rosettes. All of the affected valleys are bordered by the forest on the northwest side of the mountain. Two valleys showed evidence of extensive predation (Liki North and Teleki), with all adults destroyed in many stands. We estimate that 420 ha were affected in Teleki Valley below 4100 m. *S. keniodendron* appears to be the only alpine plant commonly eaten by elephants on Mount Kenya. *Senecio brassica* plants are occasionally eaten as well.

An elevational transect in Teleki Valley (Mulkey, unpubl. data) showed that elephants feed primarily on stands near the lower elevational limit of *S. keniodendron,* probably because these plants are more accessible. Up to 60 percent of all adult plants in stands at approximately 3800 m were affected, while less than 20 percent at 4050 m showed evidence of elephant predation. Predation in Liki North was also noted to be limited to elevations at or below 4100 m. Factors which can cause mortality in the absence of elephant feeding include sexual reproduction (Smith and Young 1982), periodic fires (B. Woodley, pers. comm.), and windthrows.

FIGURE 1. *S. keniodendron* study sites in Teleki Valley at 3900 m. A. Site lacking signs of elephant visits. B. Site with extreme, recent elephant feeding.

Juvenile plants are common on sites where elephants feed on adults (Mulkey, Smith, and Young, unpubl. data). For example, juveniles were surveyed in two 10 × 10 m plots at 3800 m in Teleki Valley, a region in which most adults were eliminated by elephants. In June 1977, before elephant damage began, there were 0.5 juvenile plants per m^2; in December 1982 there were 2.8 per m^2. The large increase in density likely resulted from a mast year in 1979–80 (Smith and Young 1982). Juveniles present in June 1977 which survived to December 1982 (4.5 yr) had an initial height (measured to highest leaf tip) of 6.7 ± 3.7 cm and showed a height increase of 6.8 ± 4.8 cm over this period. These data suggest that juvenile growth and recruitment may permit recovery from elephant predation; experimental and descriptive studies of demography are in progress and will be reported in later papers.

The number of elephants involved and the frequency of visits to the alpine zone are not known. Six to eight animals apparently live predominantly above treeline in the vicinity of Liki North Valley; the elephants visiting Teleki Valley live predominantly below treeline and visit the alpine areas only sporadically (P. Snyder, pers. comm.; Smith and Young, pers. obs.).

It is possible that the pith of *S. keniodendron* is a source of protein, used to supplement forage obtained in montane forests. It contains 17 ± 5.8 percent crude protein versus 7 ± 1.1 percent in leaves ($N = 3$). Low plant protein content can limit elephant growth during dry periods in lowland grasslands (McCullagh 1969, Laws *et al.* 1975). The pith might also be a source of mineral nutrients; similar examples of elephants using apparently noncaloric food plants are well known (Wing and Buss 1970, Weir 1972, Barnes 1980, Eltringham 1980). It seems unlikely that pith would serve primarily as a source of calories *per se,* in view of the great energy cost of both reaching the *Senecio* populations and breaking open trunks, as well as the small biomass of pith involved.

The destruction of large numbers of *S. keniodendron* adults is occurring at a rate that, if continued, could result in the local elimination of this species at its lower elevational limit. Elephants do not eat the smaller plants, so they

may eventually replace lost adults. But continued elephant feeding in some valleys could eliminate these newly recruited adults as well, reducing the probability of further recruitment. The complete removal of this important species from the lower-elevation alpine community may result in changes in the abundance of associated plant species. Resurveys of permanently marked plots are planned to monitor any long-term changes in community composition. It is unlikely, however, that *S. keniodendron* is in danger of extinction; it grows abundantly both on steep outcrops inaccessible to elephants and at elevations above 4100 m, where elephants presently do not feed. However, genetically distinct elevational ecotypes are known for tropical alpine rosette species in the Andes (Baruch 1979, Smith 1981), and it is possible that *Senecio* genotypes adapted to lower elevations may be lost in heavily visited valleys, slowing recolonization during periods of reduced elephant feeding.

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