The pattern of rainfall had a direct influence on the amount of palatable grasses, and thus, hare numbers. The increase in numbers lagged into the following dry seasons such that the correlations between hare numbers and mean monthly rainfall were not as significant as might be expected. The two burns in habitat no. 4 changed this relationship such that hare numbers were higher sooner than expected from response to the rainfall.

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6102

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Mwalyosi

Notes and Records

Decline of *Acacia tortilis* in Lake Manyara National Park, Tanzania

Introduction

The severe elephant (*Loxodonta africana* (Blumenbach)) damage to the vegetation of Lake Manyara National Park was first described by Douglas-Hamilton (in Laws, 1970). In particular, he drew attention to debarking by elephants of *Acacia tortilis* (Forsk.) Hayne spp. *spirocarpa* (A. Rich) Brenan, which dominates approximately 10% of the Park. The woodland is a habitat for browsing mammals such as elephant, rhinoceros (*Diceros bicornis* (L.), giraffe (*Giraffa camelopardalis* Matschie), and impala (*Aepyceros melampus* (Lichtenstein)). Higher mortality is reported in younger age classes (Douglas-Hamilton, 1972). There has been concern that such a trend could cause complete failure of regeneration and thus extinction of the species in the Park.

In the light of the importance of *A. tortilis* to the browsing community and its use by tree-climbing lions, detailed studies of elephant impact on the species were conducted between 1975 and 1979. This information could help the Park management to assess the relative importance of elephant damage and rainfall variability on the long-term survival of *A. tortilis* woodland.

Methods

In March 1975 the *A. tortilis* woodland vegetation was sampled by the Point Centre Quadrat (PCQ) method (Cottam & Curtis, 1956). Eight transects were randomly placed from the lake shore to the foot of the rift escarpment. Quadrats were sited at intervals of 100 m along the transects. Only trees of more than 2 cm diameter at breast height (DBH) were sampled. Both live and dead trees were enumerated and the extent of elephant damage to them estimated according to Mwalyosi (1977).

Changes in canopy cover in the woodland over 6 years was measured by comparing photographs made in 1970 by Douglas-Hamilton with ones made in 1976. All sets were enlarged to roughly the same scale and suitable plots identified. The same boundaries were marked around each plot by joining prominent trees and other objects with a straight line. Counts were then made of canopy cover using a perspex grid overlay.

In five fixed woodland transects, 297 mature *A. tortilis* were marked with numbered tags. Out of these, 180 were completely intact. The other 117 were damaged by elephants. The original state of damage to the latter was recorded according to Mwalyosi (1977). Elephant damage to all the 297 trees was recorded every 3 months over 4 years. The results were compared with those by Douglas-Hamilton (1972). One hundred and five intact young *A. tortilis* (saplings) in the recruitment and replacement category, randomly selected in the woodland, were treated in the same way.

Results

The PCQ transects showed that *A. tortilis* formed 74% of the tree population in the study area with eleven individuals ha^{-1}. Other species included *Balanites aegyptica* (L.) Del. and *Strychnos lucens* Bak. (9% and 5%). Only 60% of the recorded *A. tortilis* were alive, the rest having mostly been killed by elephants. Photoplots showed a change in canopy cover of 32·4% in 6 years (5·4% p.a.).

Out of the 297 mature *A. tortilis* ninety-four (31%) had been killed by elephants by the end of the study at an overall rate of 7·8% p.a. Twenty-five per cent of the 180 originally intact trees had been killed by elephants at a rate of 6·25% p.a. Only 56% of the 105 *A. tortilis* saplings remained viable at the end of the study. 12% were killed by elephants while the rest were badly damaged. The mortality rate of saplings was 3·0% p.a. lower than that of mature trees which were originally intact (6·25%).

Discussion

Douglas-Hamilton (1972) reported 82% and 64% living *A. tortilis* in 1968 and 1970 from total counts and PCQ measurements, respectively, suggesting a mortality of about 9·0% p.a. The 1975 PCQ measurements recorded 60% living *A. tortilis*, a 4% decrease since 1970 at a rate of 0·8% p.a. According to Douglas-Hamilton, the canopy cover change was 23·6% from September 1967 to March 1970 with an annual rate of 9·4%. The present study observed a 32·4% change in canopy cover between 1970 and 1975 at a rate of 5·4% p.a. Comparison of data from fixed transects also showed a decline in mortality of mature *A. tortilis* from 11·7% p.a. (Douglas-Hamilton, 1972) to the 7·8% p.a. found in the present study. These results suggest that *A. tortilis* mortality was highest during the late 1960s and declined during the present study period. Mature trees were killed faster than young ones (6·25% and 3·0% p.a., respectively). This is contrary to the findings of Douglas-Hamilton (1972). During the present study it was observed that as long as trees were not completely ringbarked the chance of recovery from damage and subsequent survival was higher in younger trees than in older ones. Older trees, with big boles, were more vulnerable to elephant attack than younger ones, which often grew in clumps and had their small boles well protected by their overhanging thorny branches. It was also observed that elephants tended to be attracted to mature *A. tortilis* when the latter were in fruit and as they congregated under the trees some elephants broke off branches and debarked or uprooted the trees.

Douglas-Hamilton (1972) reported that elephant tended to confine their attacks on *A. tortilis* to the rainy season. The present study supports these findings since a decline in elephant damage was observed during the present study period, which was relatively drier than the period of Douglas-Hamilton's study. The severe elephant damage to trees and the subsequent death observed in the late 1960s was probably a result of driving the neighbouring Magara elephants into the park. The situation was exacerbated by compression of elephant range due to increased human activity around the park boundaries and the record rise in the lake level, which drowned a great portion of the park in 1968–1969 confining animals to a very narrow strip of parkland. The evacuation of 7 km^2 of the Magara farmland and its incorporation into the park (Mwalyosi, 1981) has partially alleviated the problem. The relatively dry period after 1970, which led to a fall in lake level and reclamation of the drowned parkland thus allowing elephants access to dry season grassland, may have been partly responsible for the observed decline in *A. tortilis* mortality in recent years.

In summary, elephants contribute significantly to *A. tortilis* mortality and the resultant opening up of the *Acacia* woodland in Lake Manyara National Park. The severity of the problem depends on the change in the animals home range caused by human activity around the park and lake level variations, the latter depending on rainfall intensity. There is ample evidence, however, that *A. tortilis* replacement is occurring as sufficient saplings survive and reach maturity.

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