Fire, Man and Wildlife as Interacting Factors Limiting the Development of Climax Vegetation in Rhodesia

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THE GENERAL ABSENCE OF CLIMAX VEGETATION

"VIRGIN, I maintain, is only that which is bad: in Africa the swamp, the steppe, the stone land. One always detects, clear up to the mountain heights, the hand of passed generations. One finds even in the high-trunked 'primeval forest' of East Usambara the sherds of big-bellied sugar-cane-beer pots and what here passes with the uninformed as 'high meadow' is generally not original but derived from felled and burned forest." (John Booth, 1905.)

In Rhodesia vegetation which can be described (in the sense of Clements, 1916, and Phillips, 1935) as climax or near climax, in harmony with and controlled by the climate, occurs only in small isolated patches (Fig. 1), so limited that the climax (Fig. 2) can be regarded as a theoretical ideal towards which the vegetation would develop if the potency of the factors, which inhibit its advance, were reduced.

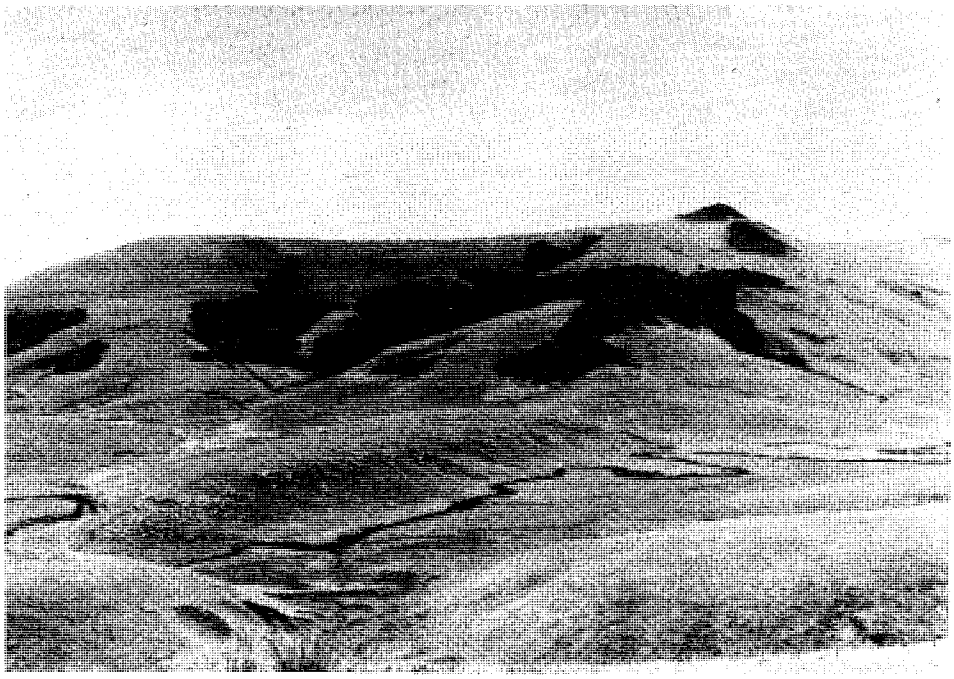

FIG. 1. Relic evergreen mountain forest. Inyanga, Rhodesia.

FACTORS LIMITING THE DEVELOPMENT OF CLIMAX VEGETATION

Phillips (1935 and in many other papers) stresses the importance of fire in retarding the development of vegetation towards the climax.

Humphrey (1962: 150) points out that "Fire has been a dominant factor down through the ages in maintaining as grasslands, areas that are climatically capable of growing either woody plants or grasses."

In West Africa, according to Hopkins (1965: 62) "During the last few hundred years there has been an increase in the area of savanna* at the expense of forest and a claim has been made for a general southward movement of all vegetation zones caused by the gradual decreasing humidity of the climate. There is virtually no evidence from the rainfall records for any change in the climate and it is likely that all these vegetation changes have been caused by human activity.

"In a natural vegetation boundary there is normally an extensive tension zone between the two plant communities. The boundary be-

* In order to avoid a multiplicity of terms, SAVANNA is used in this paper in a broad sense to include all fire controlled communities intermediate between forest and grassland.

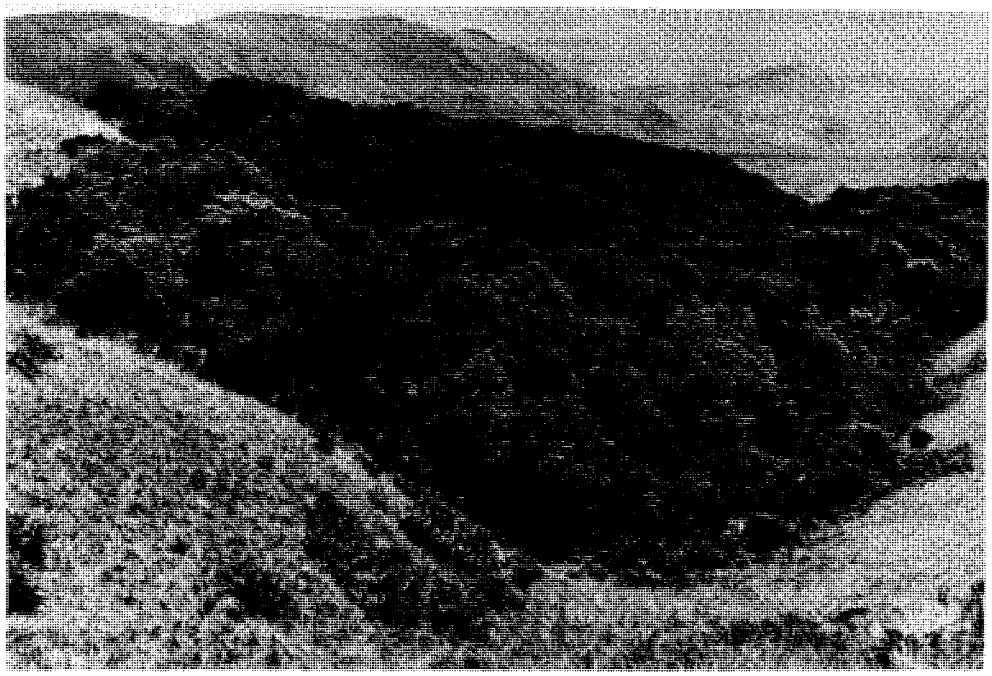

FIG. 2. Relic evergreen mountain forest. Inyanga, Rhodesia.

tween forest and savanna, however, is very abrupt (Fig. 3). The boundary here is not natural: it is a fire boundary."

On the eastern border of Rhodesia, Swynnerton (1917: 495) remarks on the "suddenness" of the patches of evergreen forest and their "non blending with the surrounding grass veld." He says, "No contrast could be stronger than that between this type of forest and the wooding of the grass veld, whether we have regard to their outward appearance or to more fundamental characteristics. The trees of the forest are intolerant of fire, the pasture trees are especially adapted to withstand it."

While the importance of fire in limiting the development of climax vegetation is widely appreciated, the overriding importance of the activities of man and of wildlife in influencing the effects of fire are perhaps not so generally recognised.

HOW FIRE AFFECTS VEGETATION

It is because of the differences exhibited by different species of plants in their degree of tolerance to burning that fire is enabled to

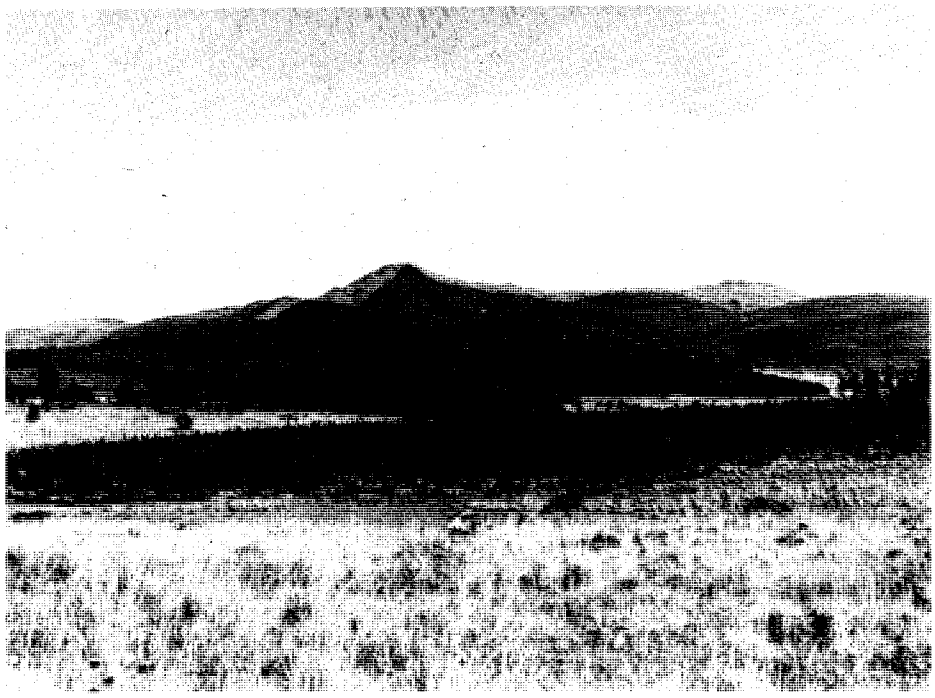

FIG. 3. The replacement of evergreen mountain forest by plantations of exotic conifers. Melsetter, Rhodesia.

exercise a selective effect on vegetation, encouraging the more tolerant species at the expense of the less tolerant.

Trees are characterised by large and permanent aerial parts. They carry their buds well above the ground. Fire harms trees physically by burning bark, killing cambium and by damaging branches, twigs, leaves and buds. If the damage is sufficiently great the tree will die and even if the tree does not die, it is exposed in its weakened condition to decay, insects and disease. Even so, different species of trees exhibit different degrees of tolerance to fire; correlated with bark thickness and composition, ability to coppice and sucker and other characteristics of individual species.

The trees of evergreen forest are nearly all highly intolerant (Fig. 4) and easily damaged by fire, but the trees which characterise important and frequently burned–over, savanna communities in the high to medium rainfall regions such as *Parinari curatellifolia* Planth. *ex* Benth., *Brachystegia spiciformis* Benth., (Fig. 5) *Brachystegia boehmii* Taub., *Julbernardia globiflora* (Benth.) Troupin, are all extremely fire tolerant. Despite this, it can be seen from the Burning Experiment at Ndola in Zambia (Trapnell, 1959) that practically all trees and shrubs will eventually be eliminated from savanna communities, if the

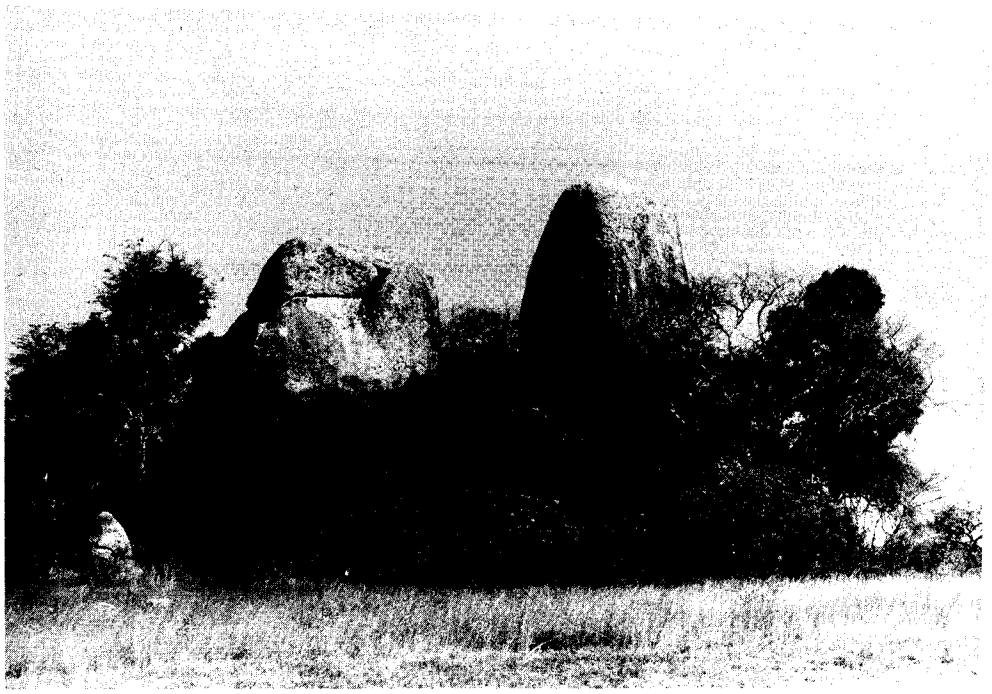

FIG. 4. Fire-tender, forest species cluster around granite boulders which protect them from fire in fire-tolerant, *Brachystegia spiciformis* Benth woodland. Rusape, Rhodesia.

fires are sufficiently intense, and repeated during the late dry season over a sufficient number of years.

Under these conditions, woody plants which persist, can only be those species which have, in the course of evolution, gone underground. I refer to the suffrutescent shrublets or "underground trees", plants which produce leafy and flowering shoots each year from a woody underground stock, often an extensive and much branched woody rhizome.

A number of species belonging to different families exhibit this life form. Important in Rhodesia are:

(Chrysobalanaceae) *Parinari capensis* Harv., (Dichapetalaceae) *Dichapetalum cymosum* (Hook.) Engl., (Anacardiaceae) *Lannea edulis* (Sond.) Engl., (Ochnaceae) *Ochna leptoclada* Oliv., *Brackenridgea arenaria* (De Wild and Dur.) N. Robson, (Combretaceae) *Combretum platypetalum* Welw. *ex* Laws subsp. *oatesii* (Rolfe) Exell. (Myrtaceae) *Syzygium huillense* Hiern, (Rubiaceae), *Pachystigma pygmaeum* (Schlechter) Robyns, *Pymaeothamnus zeyheri* (Sond.) Robyns, *Fadogia odorata* K. Krause.

Because of their unique life form, these "underground" woody

FIG. 5. Fire-tolerant, *Brachystegia spiciformis* Benth woodland near Salisbury, Rhodesia.

plants fit ideally into fire sub-climax grassland, the ultimate product of fire.

Grassland is the ultimate product of fire because it is composed of the plants, grasses and forbs, most tolerant of fire.

These plants are characterised by aerial parts that die off seasonally in response to drought and/or frosting, by dormant buds, protected from fire damage because they are either underground (geophytes), at the soil surface (hemicryptophytes) or just above the surface of the soil (chamaephytes) and by protected storage organs out of the reach of fire, such as leaf bases, bulbs, corms, rhizomes, roots, and tubers which enable both grasses and forbs to survive long periods of dormancy when conditions are unfavourable and to shoot vigorously when conditions favour growth. Also many grassland plants are able to endure repeated defoliation during the growing season.

It is not surprising, therefore, that grassland plants, both grasses and forbs, are relatively unaffected by fire, especially when these fires occur during the dormant season. In fact they may be said to be dependent on fire, because being constituents of fire sub-climax communities, they would be displaced and would disappear if fire was withheld.

Their extreme adaptation to fire is illustrated by the flowering of the pre-rain flora, which is composed of a great variety of monocotyledonous and dicotyledonous, geophytes and hemicryptophytes, which flower on burned areas before the rains begin and before the grasses shoot. This flowering is greatly encouraged by burning during the dormant season. Fire is important because it removes the previous year's cover and blackens the soil surface. This results in increased insolation and higher soil temperatures, so that, as Gordon-Gray and Wright (1969) point out in the case of *Cyrtanthus breviflorus* Harvey, in Natal, extensive flowering of a population often takes place as little as a week after firing. Some species such as *Aloe chortliriodes* Berger, which occurs in grassland on the hills around Barberton in the Eastern Transvaal, appear to flower only after burning. Referring to *A. chortliriodes*, Reynolds (1950: 126) remarks that "In cultivation plants rarely if ever flower, but sometimes flowering can be induced by surrounding the plants with quantities of dried grass and lighting it . . . In the wild state flowering plants are found on burned out slopes, but with no sign of flowers on the same slope where the veld had not been burned." (Reynolds, 1950: 126).

Burning exercises a marked effect on the flowering of the grasses too. At Tabamhlope in Natal, West (1951 and 1965) found that in plots burned during the dormant season, (1) at the beginning of winter and (2) before the first rains at the end of the dry season, *Koelaria cristata*, *Festuca scabra*, *Panicum natalense*, *Harpechloa falx*, *Themeda triandra*, *Tristachya hispida*, and *Alloteropsis semialata* were all in flower by 18th October in 1938 and 8th October, 1939, whereas in plots burned in spring after the first rains, there were no flowers at these dates, although all grasses were shooting. In plots protected from burning, there was no flowering and very little shooting.

The general effects of fire in vegetation are plain. Fire, which

usually originates in grassland or savanna, destroys forest, produces savanna and ultimately grassland. The first step in this process is the most difficult because in nature, forest is protected from fire by the seral communities composing the forest fringe, which exclude grass, and because of the uninflammable nature except in severe drought, of the vegetation of the forest floor. Opportunity for the entry of fire is usually afforded by grass growth which follows inroads made by man cultivating the fringe and/or by the destruction of the fringe vegetation by elephant and other game animals or by cattle and goats. Exceptional drought is important in aiding this process.

An example from Madagascar, illustrates how destructive fire can be once it has gained entry to forest. P. Vignal, (1956), Inspecteur des Eaux et Forets, in a report on forest destruction in Madagascar quoted by Guilloteau (1957), described how an area of 1,500 ha of virgin forest disappeared in a few days in a fire which broke out on 13th November, 1955, in the State Forest of Vohibe—Antocha. This fire spread simultaneously above and below the soil, the subterranean front advancing at a depth of 5–10 cm below the surface. Trees whose roots were burned by the litter fire, died, then were rapidly felled by the wind or their own weight. This conflagration resulted from the spread of a fire used in clearing forest during a period of severe drought. (N.B. Clearing for cultivation and fire both ascribable to man).

Once forest destruction has been brought about, the stage to which the vegetation is reduced depends on the severity and frequency of successive fires. If these are frequent and of sufficient severity, the end product will be grassland.

FIRE CAUSED BY NATURAL PHENOMENA

It has long been recognised that fire in vegetation can be caused by various natural phenomena and happenings entirely unconnected with man's activities.

Harris (1958) working on fusian (fossil charcoal) has shown that fires which destroyed vegetation were not infrequent in the Mesozoic before the advent of man.

Fires have been caused by volcanic eruptions and in India, Henni-

ker-Gotley (1936) observed a fire started by sparks struck by quartzite boulders rolling down a slope. The boulders were dislodged by a falling tree. As has been stressed by Komarek (1966, 1967) the most important of these natural causes is undoubtedly lightning.

In the present age there are numerous records of fires caused by lightning. Sir Harry Johnston (1906) stated that he frequently witnessed the ignition of African veld by flashes of lightning. Staples (1926: 12) recorded that a protection plot at Cedara in Natal was accidentally burned by lightning on January 3, 1924. Phillips (1930) stated that his observations and those of forest officers in East and South Africa support the view that lightning was responsible for commencing many fires.

In Rhodesia where the rainfall is seasonal and confined to a comparatively short period during the summer months and where ground frosts occur at night over most of the land surface during the dry, winter months, conditions particularly suitable for widespread fires develop annually during the dry season, and often during dry periods in the rainy season.

Because of this, lightning fires are not uncommon in Rhodesia. This is borne out by the records of the Forestry Commission and the National Parks. Recent definite records include:

1) In the **Eastern Districts,** three grass fires in the late afternoon at Melsetter in 1962 (Whiteside, 1962) and two grass fires at about midday on January 19th 1969, at Inyanga (Tracey, 1969).

2) In the **Souther Midlands,** in the Kyle National Park, south of Fort Victoria, a grass fire at about 3 P.M. on January 16, 1971. (Ferrar, 1971).

3) On the **Western border,** on the Nyamandhlovu Experiment Station, a grass fire at about 3:30 P.M. on October 24, 1967 (Denny, 1967), and in the Victoria Falls National Park, a fire in vlei grassland during the afternoon of November 2, 1970 (Herbert, 1971).

The Inyanga fires were remarkable in that they occurred during a particularly good rainy season when the season's rainfall total had already reached 26 inches. The two fires arising from separate strikes, about five minutes apart, produced clean burns of about 50 acres each, before they were put out by National Park staff. These fires

occurred in grassland which had been protected from fire for some years and which contained much old, dry grass.

The fire at Kyle occurred in tall Hyperthelia grassland and was put out by rain after 10 acres had been burned. The Victoria Falls fire occurred in vlei grassland and was also put out by rain after about 100 acres had been burned.

Such lightning fires undoubtedly played their part in molding vegetation long before the advent of man, but the full potency of fire in affecting vegetation by producing and maintaining fire subclimax communities was probably not reached until man had discovered how to make fire and use it in furthering his activities.

THE USE OF FIRE BY PRIMITIVE MAN

The earliest positive evidence of the use of fire by man in Central Africa is associated with the Chelles-Acheul and perhaps the Faure-smith Stone Age Industries, which (from a carbon dating at the old Kalambo site on the borders of Zambia and Tanzania) flourished more than 53,000 years ago (Clark, 1959).

(It is possible that fire was used much more anciently. Professor Dart was convinced that the Makapan Australopithecine used fire and because of this, named him *Australopithecus prometheus*. His evidence for this conviction is not regarded as conclusive by other archeologists, but if positive evidence were forthcoming, it would mean that fire was being used about 800,000 years ago (Ardrey 1970: 108).

Stone Age Man used fire for heat, for cooking, in gathering honey and in hunting. Burchell (1822) records that the Bushman burned old grass to attract game.

Iron Age Man represented by the crop growing, cattle–owning Bantu Peoples, who entered Rhodesia from the north from A.D. 90 (Clark 1959), used fire for these same purposes as well as in their cultivation of crops, for providing fresh grass for their livestock, in burning charcoal and in smelting iron. In addition, fire had acquired a religious significance and was employed extensively in rain making.

Charcoal and Iron:—The Iron Age peoples were distinguished by their ability to smelt iron from the ore and to use iron in the manu-

facture of weapons and implements. For their smelting and forging, they used charcoal and in gathering wood for burning charcoal, they made extensive inroads on the forests and woodlands. Dr. Livingston (1875: 129) writing in Zambia near Silubi's village remarks that, "The whole of this upland region might be called woody, if we bear in mind that where the population is dense, and has been long undisturbed, the trees are cut down to the size of low bush (or) over large districts are kept to about the size of hop-poles, growing on pollards three or four feet from the ground, by charcoal burners, who in all instances are smiths too."

Honey Gathering:—From the earliest times, as at present, fire used in gathering honey must have been responsible for much accidental burning of vegetation.

Hunting:—In hunting, fire was used intentionally either to produce green grass to attract game, (Burchell, 1822), by burning moist areas towards the end of the dry season after ground frosts had ceased, or for driving game, or as happened at Bindura (see below), to provide a refuge in which game would concentrate to be hunted later.

There is much evidence that fire was widely used in hunting in Rhodesia. Broderick (1962) says "The name Bindura, is said to be an anglicised version of Pindura, which was derived from the fact that the chief used to send out word in August and September to his people in the vicinity of Bindura Hill. This would cause the people to set fire to the veld for miles around and in such a manner as to leave the hill itself untouched. The game would flee before the flames and take refuge in the unburned vegetation around the hill. Then on another given date, the chief would cause an organized hunt, through that vegetation, thus giving a plentiful supply of meat for his tribesmen." Bindura is about 40 miles northeast of Salisbury.

In a Department of Internal Affairs memorandum on Traditional Conservation Practices in Southern Rhodesia (1962), it is stated of the Ndebele Tribe who are of Zulu origin and occupy Matabeleland, "The Zulu Chiefs exercise considerable control over their people and this was reflected in the control over hunting and cattle . . . The Ndebele paramounts appear to have had special areas where only they were permitted to hunt by burning." (Posselt 1962). Of the Mashona tribes, it is stated that "Veld burning (was) not intention-

ally a conservation practice, but a side effect was the reduction of woody growth and the stimulation of grasses."

Swynnerton (1921:325) writing of the Chipinga, Melsetter area on the south-east border of Rhodesia and of adjacent Moçambique, says "It is stated that under the Zulus, burning was the subject of regulation for hunting purposes, a late, thorough burn being aimed at and usually achieved." (Swynnerton is referring to the people of Chief Manikusa, his son Umzila and grandson Gungunyana).

Hunting fires were usually late dry season burns.

Rain Making:—In Rhodesia where the year is strictly divided into a short wet season followed by a long dry season the onset of the rains is eagerly and sometimes despairingly awaited by grazier and cultivator alike.

It is not surprising therefore that the magic of rain making is very important and widely invoked.

In rain making, fire plays an important part. Burbridge (1938) tells us that the general firing of grass is regarded as a necessary preliminary to a plentiful rainy season. In most years some areas were burned for hunting and some for grazing, but as the rains approached it was customary to set fire to all unburned hills throughout the country to ensure a good season.

In addition to this ordinary burning carried out by the general populace, some ranges and hills are burned mysteriously.

Sikovene near Essexvale, south-east of Bulawayo, is a small range which ignites mysteriously before the first rains each year. If the fire does not materialize it is held that the season will be a poor one. The Munaka Range, south-west of Fort Victoria, in the Chibi Tribal Lands, is said to burn in a similar manner.

These rain making fires were very late dry season burns.

Grazing:—"It is known that the Zulu peoples adhered strictly to the custom of late dry season burning for hunting." (Swynnerton, 1921: 325). The Zulu were cattle owners and it is certain that they appreciated the importance of these hunting fires in providing suitable grazing for their cattle. In Matabeleland populated by the Ndebele tribe who are of Zulu origin, there is a tradition that under the Ndebele kings, the country was systematically burned during the late dry season, in three huge segments centered on the King's Kraal

at Bulawayo. In the first year, burning would be confined to the segment between Nyamandhlovu and Insiza, in the next to that segment lying between Insiza and Gwanda, and in the third year to the remaining segment between Gwanda and Nyamandhlovu (Kennan, 1971).

Swynnerton (1917: 501–502) writing about the Chirinda Forest in the Chipinga area, mentions late fires which "were in vogue during the native regime" as an accelerating factor in the destruction of forest. He says "According to all accounts, most of the burning was annually postponed till September and October when the grass is very dry and the forest fringe and carpet is also at its driest . . ."

R. St. J. Brislin (1962) reports a traditional grazing practice from Lupani in the north-west, where gusu (*Baikiaea plurijuga* Harms) covered, sandy ridges alternate with basaltic valleys: "In October each year it was the practice to burn out all gusu ridges in order to burn the dry leaves and allow the growth of grass for stock grazing after the rains. When cattle were grazed in the gusu ridges the grass in the valleys and on the stream banks was burnt and no stock was allowed to graze there until winter when the grass had tassled. It was felt that the accumulation of leaves in the gusu killed the grass or impeded its growth."

R. J. Powell (1962) writes of the Ukababela custom from Plumtree in western Matabeleland.

"This custom normally refers to the controlled burning of fireguards but in this district it is reported to have another significance and to have been widely practiced in the past. Small selected areas in the close vicinity of kraals are burnt so that young calves and young goats will have green grass to eat. This is done towards the end of the dry season.

It used to be customary for extensive burning of grass to be undertaken after the first rains, not for the purpose of providing grazing, but in order to get rid of ticks. Elderly Africans here state that legislation in respect of veld fires has resulted in a big increase of ticks."

Cultivation:—Bartlett (1955 and 1957) has shown how universal were the primitive systems of shifting agriculture, by which forest was slashed or felled and burned for crops grown in the ashes. By inference from studies of primitive Iron Age Man in historical times,

gardens or fields produced in this way were cultivated for a few years only, until the fertility of the soil was exhausted. They were then abandoned in favour of new gardens slashed from virgin areas where the accumulated fertility of the ecosystem could again be exploited. In the abandoned fields perennial grasses following annual weeds in the natural course of the plant succession, provided areas where fire could take hold and eat into the surrounding forest.

When the human carrying capacity of land under shifting cultivation is considered, the importance of this form of land use in its effects on the vegetation becomes plain.

Allan (1965: 110) shows that in the Citemene types of slash and burn cultivation practiced in Zambia, the period of woodland regeneration required between slash and burn croppings, could vary between 22 and 25 years in some areas but might have to be much longer in areas less favorable for tree growth.

On the Serenje Plateau, Peters (quoted in Allan, 1965: 112) found that 7 out of 11 samples represented growth of more than thirty years. He found that the carrying capacity of the country occupied by the Serenje Lala practicing Small Circle Citemene was between five and six persons to the square mile but considered that at this density the cutting cycle had been dangerously shortened and that the population density should not exceed four persons to the square mile. In Large Circle Citemene as practised by the Maswepa Mambwe and other peoples, Allan (1965: 131) suggests that the critical population density varies from 4 persons to the square mile in the poorer woodland and hill regions to perhaps 16 per square mile in the most favourable sites.

It is obvious that at these very low population densities, a comparatively small human population practising shifting cultivation would affect vast areas of land.

In Rhodesia where population density has become too great to allow a bush fallow rotation, fire is used in October, to clear tall grass before land is cultivated. In the Eastern districts the need to get rid of Buffalo beans, (*Mucuna coriacea* Bak.), which are covered with highly irritant, stinging hairs, provides an additional reason for burning land about to be cultivated.

It should be noted that burning for the purpose of hunting, rain

making, grazing and sometimes in preparing land for cultivation, in fact for many of the reasons for which fire was purposefully applied to vegetation, often took place in the late dry season. This is significant because it is the late dry season burns that are the most effective in depressing woody vegetation and in encouraging grass (West, 1965: 34).

MAN, FIRE, AND ELEPHANT

The elephant is a relatively unspecialized mammal, preferring a mixed diet of grass and browse, but able to exist on browse with very little grass or on grass with very little browse. In Africa, elephants are found over a vast range of habitats from the hot tropics to the temperate south, and from sea level to altitudes greater than 3,300 m.

Laws (1970) remarks that "after man himself, probably no other animal has had as great an effect on African habitats". (Figs. 6 and 7) He considers that under optimal conditions grass would comprise about 50 percent of the elephants diet and he correlates an increasing proportion of grass in the diet with an increasing degree of habitat change "from bush or woodland to grassland, (and in the elephant) poorer conditions as measured by kidney fat indices or the height–weight relationship and increasing extent of population regulatory mechanism such as delayed maturity and longer calving interval", but because of its long life span, these regulatory processes are slow to take effect, and so an overlarge elephant population crowded by outside pressure into too small an area is able to produce conditions which favour the conversion of forest, woodland, etc. to grassland by fire.

As long ago as 1917, Swynnerton (1917: 501) suggested that elephant and fire may have been two of the factors responsible for the replacement of "the ancient east african forest" by wooded pasture land. Referring to elephant he says, "my recollection of their work in the Sitatonga Forest (in Moçambique) in which they were somewhat plentiful at the time of my visit, leads me to suspect that the rather poor forest that tends to occur on the poorer sandy soils in

FIG. 6. A large *Pterocarpus angolensis* DC. ring barked and killed by elephant in the Wankie National Park, Rhodesia.

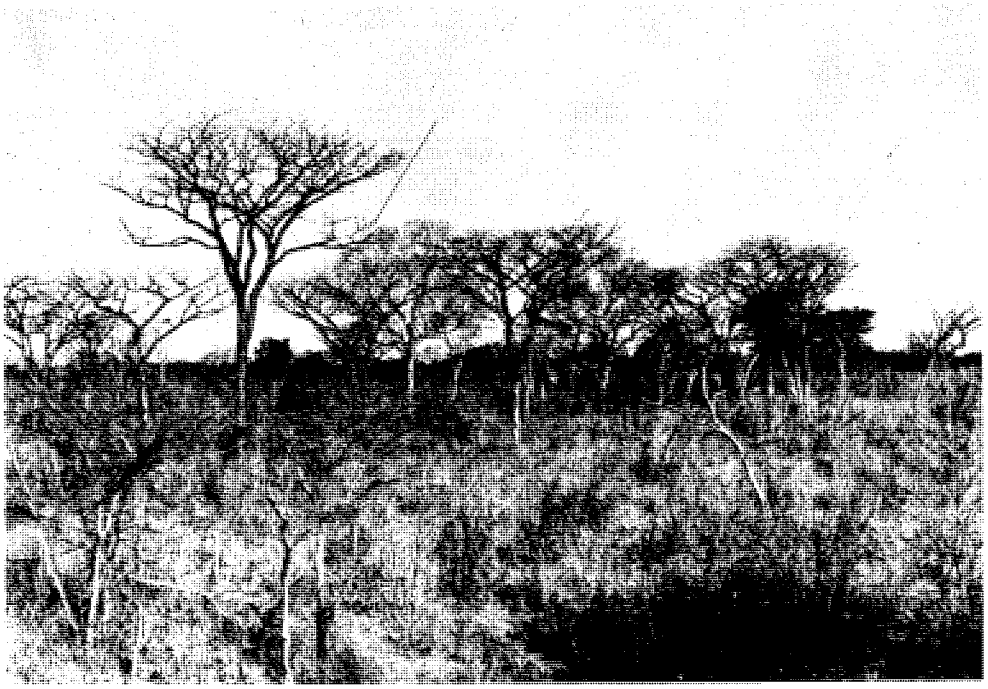

FIG. 7. A grove of *Pterocarpus angolensis* DC. All the trees in this grove have been ringbarked by elephant and are either dead or dying. Wankie National Park, Rhodesia.

Chirinda would be more liable to such damage by elephants as might tend to let fire in."

The last sentence is a very significant one, referring as it does to a process which is now extremely obvious in many of the great National Parks in Africa.

"In Murchison Falls National Park, located in tropical Uganda, East Africa, luxuriant wooded grassland, terminalia woodlands, cynometra rain forests and riparian forests are in process of conversion through the combined action of elephants and fire . . . As the woodlands and the scattered trees in the grasslands are destroyed, grassland vegetation characterized by *Hyparrhenia filipendula*, *Brachiaria brizantha*, and *Andropogon canaliculatus* increases in distribution." Buechner and Dawkins (1961: 765).

Ford (1966) explains "The mechanisms of destruction of trees being a combination of debarking and breakage by elephant followed by grass fires, which the damaged trees normally pyrophitic, can no longer resist." Buechner and Dawkins (1961: 765) conclude that "the basic cause of these conspicuous rapid changes in vegetation seems to lie in an extraordinary increase in the population of elephants" within the park.

Laws (1970) ascribes the increase in elephant density to the human population explosion: "man's progressive occupation of land and the consequent restriction of the ranges of wild animals."

A similar process can be observed in many of the National Parks of Africa, e.g. in the Serengeti (Laws, 1970), in the Tsavo (Glover, 1963; Agnew, 1968; Laws, 1970), in the Ruaha (Savidge, 1968), and in the Kruger (Van Wyk and Fairall, 1969).

In Rhodesia the process is obvious in areas where hunting pressure or land development by man, in taking up more and more of the range of elephant, is compressing elephant populations into National Parks and other refuge areas, some parts of which have become grossly over-populated, e.g. in the Wankie National Park and in the Gona-Re-Zhou.

THE EFFECTS ON THE VEGETATION OF RHODESIA

While fire began to affect vegetation from the very earliest times and long before man appeared (Harris, 1958), the number and frequency of fires and their effect on the vegetation must have increased when man learned to make fire and use it for various purposes.

However, because of the low population densities and limited use of fire by man during the Stone Age, it is probable that the effects produced by fire during the stone age occupation were not nearly as significant in modifying plant communities as they became later when Iron Age Man, herding cattle, practicing a shifting, slash and burn agriculture and using fire for a great variety of purposes entered Rhodesia from the North.

Iron Age Man entered Rhodesia during a period when the climate was much the same as the present, and the rainfall considerably less than it had been in the previous pluvial period (Summers, 1960). This means that when Iron Age Man arrived the rainfall was marginal for forest then existing over large areas of Rhodesia and because of this, forest was destroyed much more easily by his activities.

This is in accordance with the views of Aubreville (1937, 1947, 1949 a and b, 1950) who presents a most depressing picture of forest destruction and its replacement by savanna vegetation over most of tropical and southern Africa. Aubreville maintains that while

changes in climate may have induced a state of physiological disequilibrium with the environment, which made forests in some parts easier to destroy, the major cause of destruction was man's activities assisted by fire. Fire upset the delicate balance that had been established between forest and the drier climate.

It is certain that during the 1,800 years (approximately) which have elapsed since the first entry of Iron Age Man (Clark, 1959) and the beginning of European settlement, spectacular changes in the vegetation of Rhodesia have been brought about, mainly through the burning and cultivating activities of Iron Age Man. Forest has been almost entirely destroyed. Only relic patches remain but these relics, protected for a number of reasons, show that forests of various types must once have been extensive. Many of the existing relics, the so called "sacred groves", are protected by taboo or custom because they are the burial grounds of chiefs or other important people, or because they are regarded as the homes of the ancestors of the clan or tribe. Some have been preserved because it was customary to protect groves around springs or pools, to preserve the water which it was believed, would dry up if the trees were removed. Many relic patches of mountain forest in particular have been preserved simply because they were inaccessible or grew on land too steep and broken for cultivation were protected from fire by the topography.

Evergreen Forests in the Eastern Districts

The numerous relics of evergreen forest of various types which occur throughout the Eastern Border Districts show how extensive forest must once have been in this region of high and dependable rainfall.

Archeological and botanical evidence shows that much of the land in the Eastern Districts was once heavily populated and extensively cultivated. North of Umtali, in the Inyanga District, many of the steep slopes are terraced. Hills are crowned with ruined forts while numerous pit structures and ancient water furrows bear witness to the numbers and ingenuity of the former inhabitants. The forest relics spread over such a large area, show how successful these people were in destroying forest.

That these forest relics are not post-climax patches lingering on in

specially favoured situations is proved, by the speed at which they expand when afforded protection from fire. Swynnerton (1917: 511) describes this process in Chipete and on his section of Chirinda which he had protected for fifteen years. "The green fringe of *Hypoestes aristata* has pushed in places as much as 40–50 yards into the grass and is supplanting it . . . and the large shrubs *Vernonia podocoma* and *Vanguera apiculata* and small laburnumlike *Calpurnia lasiogyne* are following up this advance and making a thicket. Most prominent of all, however, is the semi-tolerant species *Albizia fastigiata chirindensis*. While the fires lasted this tree hugged the forest, but now is thrusting out boldly into the grass-veld individually up to eighty and a hundred yards . . . the forest proper is slowly bringing up the rear as the shade advances with a small but quite definite advance of from three to five yards . . . only in one place, a broad indention of Chipete, has the forest advanced as yet in a really sensational manner—90 yards at the deepest spot. It has been enabled to do this under cover of the shade of thorn trees . . ."

Chirinda and Chipete are not unique in their ability to expand when afforded protection from fire. Similar advances have been observed in protected areas on the Melsetter Pasture Station and at Inyanga where on the Mtinderere—Pungwe divide, I have seen evergreen mountain forest growing over ancient terracing.

Swamp Forest

Vleis in Rhodesia are gently sloping, grass covered, valley drainage lines, often seasonally waterlogged by seepage from surrounding high ground and containing springs as well as swamp and marsh areas (c.f. Zambian Dambo). Because of the moist soil, crops can be grown over much of the vlei area during the dry season and for this reason vleis were intensively used for dry season gardening by the Iron Age cultivators, so much so that a whole range of specialized cultivation techniques for the growing of different crops on various types of vlei ground have become traditional.

Tsenza (*Coleus esculentis* (N. E. Br.) G. Taylor) was extensively cultivated on "Mahombis", steep narrow banks separated by ditches. Rice and other crops were grown on smaller "ridge and ditch" or on "mound and pit" arrangements.

Relic patches of swamp forest located in the wettest and therefore most unuseable portion of the vlei, indicate that these vlei areas were once covered by forest, which is now almost completely destroyed by the cultivating and burning activities of Iron Age Man.

Other Vegetation Types

In addition to the evidence for forest destruction there is much evidence to show that the Brachystegia woodlands as well as the areas of grassland which cover much of the higher rainfall watershed country have resulted from the effects of man's activities, cultivation, fire and the grazing of cattle, in ancient times.

These effects most marked in the higher lying, Tsetse-free watershed country, are less obvious but not absent in the lower lying, dry savanna capable of harbouring Tsetse. Here riverine forest located on alluvial deposits, has been reduced to relic proportions and much parkland savanna has been created by selective clearing and cultivation. Interesting thicket communities comparable with but much less extensive than the thicket communities in Tanganyika, occur on sandy soils in the north-east as well as in the Urungwe and Sebungwe areas of the Zambesi Valley and in the Sanyati Valley. It is of interest that Fossbrook (1957) found that thicket in Northern Tanganyika hides prehistoric rainponds and wells associated with a former cattle-owning people.

Descriptions written by Selous (1893) and other travellers who visited Rhodesia before and soon after the arrival of the Pioneer Column, stress the openness of the countryside and indicate that during the Iron Age Occupation, a small human population, with fire and shifting cultivation, had established a trend which favoured the development of open savanna and grassland while it discouraged dense bush and forest.

European colonisation which began with the arrival of the Pioneers, less than 100 years ago, resulted in a sudden increase in the population of both humans and cattle. The indigenous human population had increased from approximately 500,000 in 1901 to 5,050,000 in 1970; the cattle population from about 25,000 head after the Rinderpest Epizootic in 1898 to more than 5,000,000 in 1970.

The growth of the human population was so large and rapid that the old shifting life soon became impossible. Land was enclosed and

the population fixed by the demarcation of tribal and farming areas.

Increased grazing pressure consequent on the growth of the livestock population, consumed the surplus grass which was formerly burned and lack of fuel began to limit the role of fire in producing and maintaining grassland.

So over much of the drier country used for grazing cattle, the trend towards openness established during the Iron Age Occupation has been reversed.

This reversion, which if it were allowed to proceed could result in the redevelopment of climax communities, can only be regarded as a phase in the history of the changes brought about by man.

The increase in population coupled with the need for more production from the land has led to a remarkable growth in the acreage of plantations and agriculture.

The high rainfall regions in which evergreen forest could develop are being increasingly used for the production of timber from exotic trees species, of tea and coffee, of deciduous and tropical fruits. Much of the higher to medium rainfall country is devoted to the extensive cropping of maize, cotton, tobacco, and groundnuts while great stretches of dry country in the lowveld are irrigated for the production of sugar, wheat, cotton, and other crops.

So now the trend is towards the destruction and replacement of the natural vegetation by cultivated species, selected for their use in supplying the material needs of man and his domestic animals.

Of the wild country required for man's aesthetic needs, only the national parks, reserves, and wilderness areas will remain and because these are of limited extent and are profoundly affected by pressures set up by development outside their borders, their management to secure the future of both the vegetation and the animals becomes increasingly important.

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LITERATURE CITED

Agnew, A. D. Q. 1968. "Observations on the changing vegetation of Tsavo National Park (East). East Africa Wildl. J. 6: 75-80.

Allan, W. 1965. The African husbandman. Oliver & Boyd, London.

Ardrey, R. 1961. African genesis. Reprinted 1970. Collins. Fontana Books. London.

Aubreville, A. 1937. Dix années d'expériences sylvicoles en Côte d'Ivoire. Rev. Eaux. For. 75 (4): 289–302; 75 (5): 385–400.

———. 1947. The disappearance of the tropical forests of Africa. Unasylva 1: 5–11.

———. 1949a. Climats, forêts et désertification de l'Afrique tropicale. Soc. d'Edit. Georgr., Marit. et Colon. Paris.

———. 1949b. Contribution à la paléohistoire des forêts de l'Afrique Tropicale. Soc. d'Edit. Geogr., Marit. et Colon. Paris.

———. 1950. Flore forestière Soudano—Guinéenne, A.O.F.—Cameroun—A.E.F. Soc. d'Edit. Geogr., Marit. et Colon. Paris.

Bartlett, H. H. 1955. Fire in relation to primitive agriculture and grazing in the tropics. Annotated bibliography. In: Int. Symposium, Man's role in changing the face of the Earth. Ann Arbor, Univ. Michigan Bot. Gdns.

———. 1957. Fire in relation to primitive agriculture and grazing in the Tropics. Annotated bibliography. Vol. II. Ann Arbor, Univ. Michigan Bot. Gdns.

Booth, J. 1905. Der Bezirk Ssongea. Beihefte zum Tropenpflanzer, 6, Heft 4/5: 263-276. (Quoted from Barlett 1957, p. 169).

Breslin, R. St. J. 1962. Memo. on traditional conservation practices in the files of the Ministry of Internal Affairs, Salisbury, Rhodesia.

Broderick, G. R. 1962. Memo. on traditional conservation practices in the files of the Ministry of Internal Affairs, Salisbury, Rhodesia.

Buechner, H. K. and Dawkins, H. C. 1961. Vegetation change induced by elephants and fire in Muchison National Park, Uganda. Ecology 42: 752-766.

Burbridge, A. B. 1938. Uncontrolled grass and forest fires and their prevention. Bull. 1081. Dept. Agric. Southern Rhodesia.

Burchell, W. F. 1922-4. Travels in the interior of Southern Africa Reprinted 1953. Batchworth Press, London.

Clark, J. D. 1959. The prehistory of Southern Africa. Penguin Books, London.

Clements, F. E. 1916. Plant succession; an analysis of the development of vegetation. Publ. 242, Carnegie Inst., Washington.

Denny, R. 1967. Senior Pasture Research Officer, Matopos Research Station. Personal Communication.

Ferrar, A. 1971. Biologist, Department of National Parks and Wildlife Management, Salisbury, Rhodesia. Personal Communication.

Ford, J. 1966. The role of elephants in controlling the distribution of tsetse flies. I. U. C. N. Bulletin New Series No. 19 April/June. 6.

Fossbrook, H. A. 1957. Prehistoric wells, rainponds and associated burials in Northern Tanganyika. Proc. 3rd. Pan-Africa Congr. Preh. 326-335.

Glover, J. 1963. The elephant problem at Tsavo. East African Wildl. J. 1:30-39.

Gordon-Gray, K. D. & Wright, F. B. 1969. *Cyrtanthus breviflorus* and *Cyrtanthus luteus* (Amaryllidaeae). Observations with particular reference to Natal populations. J. South Africa Bot. 35 (1): 35-62.

Guilloteau, J. 1957. The problem of bush fires and burns in land development

and soil conservation in Africa south of the Sahara. Solis Africa 4 (2): 64-102.
Harris, T. M. 1958. Forest fire in the Mesozoic. J. Ecol. 46 (2): 447 453.
Hebert, J. 1971. Biologist, Department of National Parks and Wildlife Management, Salisbury, Rhodesia. Personal Communication.
Henniker-Gotley, G. R., 1936. A forest fire caused by falling stones. Indian Forester 62: 422-3.
Hopkins, B. 1965. Forest and savanna. Heinemann. London.
Humphrey, R. R. 1962. Range ecology. The Ronald Press Co. New York.
Kennan, T. C. D. 1971. Grasslands Research Station, Rhodesia. Personal Communication.
Komarek, E. V. 1966. The meteorological basis for fire ecology. Proc. Tall Timbers Fire Ecology conf., no. 5, pp. 85-125.
———. 1967. The nature of lightning fires. Proc. California Tall Timbers Fire Ecology Conf., no. 7, Hoberg, Calif., 5-41.
Laws, R. M. 1970. Elephants as agents of habitat and landscape change in East Africa. Oikos, 21 (1): 1-15.
Livingstone, D. 1875. The last journals of David Livingstone in Central Africa. . . . Jansen, McClurg & Co., Chicago p. 129 (Quoted from Bartlett 1955, p. 378).
Phillips, J. F. V. 1930. Fire: its influence on biotic communities and physical factors in South and East Africa. South Africa J. Sci. 27:352-67.
Phillips, J. F. V. 1935. Succession, development, the climax and the complex organism: an analysis of concepts. 2. Development and the Climax. J. Ecol. 23 (1): 210-46.
Posselt. J. 1962. Memo. on traditional conservation practices in the files of the Ministry of Internal Affairs, Salisbury, Rhodesia.
Powell, R. J. 1962. Memo, on traditional conservation practices in the files of the Ministry of Internal Affairs, Salisbury, Rhodesia.
Reynolds, G. W. 1950. The Aloes of South Africa. The trustees, the Aloes of South Africa Book Fund, Johannesburg.
Savidge, J. M. 1968. Elephants in the Ruaha National Park, Tanganyika Management problem. East Africa Agric. For. J. 33: 191-196.
Selous, F. C. 1893. Travel & adventure in South Africa. Rowland Ward & Co. Ltd., London.
Swynnerton, C. F. M. 1917. Some factors in the replacement of the ancient East African forest by wooded pasture land. South Africa J. Sci. 14: 493-518.
Swynnerton, C. F. M., 1921. An examination of the Tsetse problem in North Mossurise, Portugese East Africa, Bul. Entom. Res. 11 (4).
Staples, R. R. 1926. Experiments in veld management. First Report. Sc. Bull. 49 Union of South Africa Dept. Agric.
Summers, R. 1960. Environment and culture in Southern Rhodesia: a study in the "personality of a landlocked country." Proc. American Phil. Soc. 104 (3): 266-292.
Tracey, L. T. 1969. Salisbury, Rhodesia. Personal communication.
Trapnell, C. G. Ecological results of woodland burning experiments in Northern Rhodesia. J. Ecol. 47 (1): 129-68.
Vignal, P. 1956. La disparition de la foret Malgache des hauts plateaux. Bois Forêts Trop. 49: 3-8.
Van Wyk, P. and Fairall, N., 1969. The influence of the African elephant on the vegetation of the Kruger National Park, Koedoe 12: 57-89.
Whiteside, J. O. 1962. Department of Res. & Specialist Services, Rhodesia Min. Agric. Personal Communication.

West, O. 1951. Vegetation of Weenan County, Natal. Mem. 23, Bot. Survey South Africa.

———. 1965. Fire in vegetation and its use in pasture management with special reference to tropical and sub-tropical Africa. (Mimeo) No. 1/1965. Commonwealth Bureau of Pastures and Field Crops, Hurley, Berkshire, England.