FIG. 1. Whitebract hymenopappus (*Hymenopappus scabiosaeus*). This biennial forb was abundant in the foreground pasture burned May 1, 1963 and scarce in the background pasture burned May 1, 1964. Photo by Kling Anderson, May, 1965.

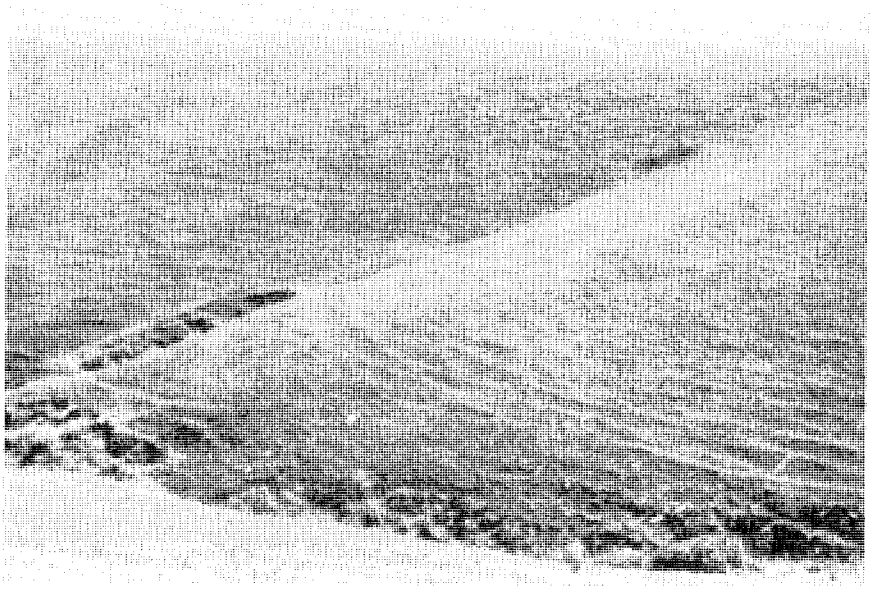

FIG. 2. Cattle trails show after burning away the old grass. About a week has elapsed and new growth is about 3-4 inches tall. These cattle trails are a fairly common feature of permanent pastures. Photo by Kling Anderson.

Fire Ecology—Some Kansas Prairie Forbs*

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WHEN EUROPEANS who had settled the east coast reached the central portion of this continent in their westward migration, they came upon a vast grassland stretching from Canada to Mexico and extending to the Rocky Mountains. In this new and strange vegetation they found many wonderful plants. The vegetation as a whole, and especially the dominant grasses, furnished what seemed to be an unlimited supply of forage for the countless wild animals that ranged over the area, and the new settlers found that prairie vegetation had helped make the soil rich beyond their hopes. That soil, through its vegetation and its wildlife, furnished all food and shelter required by the Indian, supplied his medicines and many of his charms and potions, served as a basis for many of his legends and customs, and gave him much of the beauty in his life. The prairie Indian was truly a product of his environment, and vegetation was no small part of that environment.

Grasses make up the bulk of the vegetation of the prairie, but shrubs, and especially forbs, occur in seemingly endless numbers of species and individuals, lending color and variety to the landscape. Their pattern, ever changing with the advance of the seasons, is repeated faithfully year after year. They may be subdued in dry years

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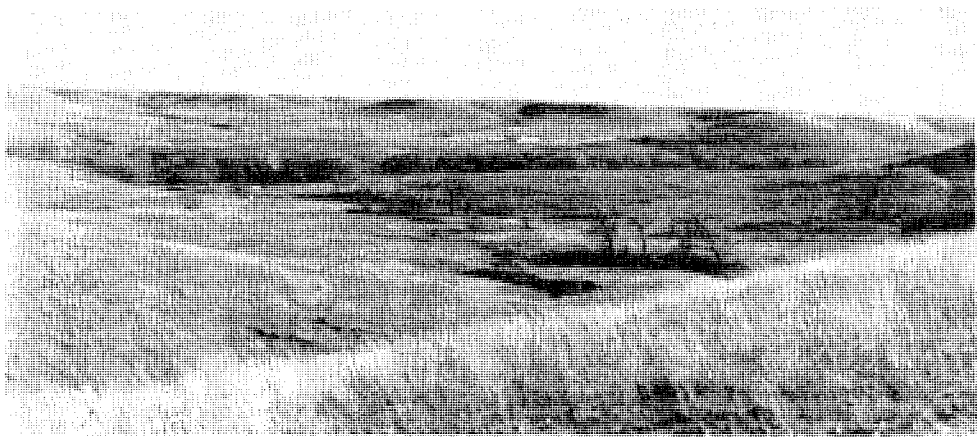

FIG. 3. View of a true prairie grassland dominated by big and little bluestem (*Andropogon gerardi* and *A. Scoparius*) and other associated grasses. Tree growth, mostly oak and elm, is limited to the lowlands and extends up the draws. It extends out and up under depletion and with the exclusion of fire. Photo by Kansas State Univ. Photo Services Lab.

but, with the recurrence of soil moisture, they burst forth with extra vigor as if to make up for time lost earlier.

Most forbs of the prairie are perennial, although annuals occur in disturbed areas; and even in the climax certain annuals may be found in the spring before the grasses begin to compete strongly for moisture and light. Heavily disturbed areas, on the other hand, are filled with annuals, many of exotic origin.

Many of the perennial forbs have ephemeral tops that appear only briefly in the spring, but long enough to blossom, mature their crop of seeds, and manufacture the energy foods required both for current growth and for storage in their subterranean parts to carry them through their long period of dormancy. This entire growth sequence may take place before the grasses have made significant top growth and thus before they have begun to compete strongly for light and moisture. Perennial forbs of that type cannot truly be said to compete with the grasses.

Another large group blossoms at or soon after the time grass tops emerge. Many of them mature and disappear from the scene and become dormant early in the summer. They, too, mostly escape direct competition with the grasses. Still others blossom later in the season, some as late as September, or even October. Thus, there is a steady succession of beautiful and often fragrant wild flowers from earliest spring until plant tops are killed by low temperatures in the fall. Many fall-blooming forbs actually emerge early and grow vegetatively the entire season before blossoming.

Competition for the elements required for plant life, especially water (soil moisture), is severe in the prairie. Studies have shown that each summer from early May to mid-August there occurs a gradual decline in the amount of soil moisture even though this is the season of greatest precipitation. It is also the period of greatest plant growth, approximately 90% of the season's top growth having been made by mid-August. Thus soil moisture use is heavy during that time, greater in fact than the amount normally supplied by rain that falls during the period, hence the withdrawal of moisture reserves. Replenishment of the reserve occurs at times of the year when precipitation is light, but those are also seasons of little moisture use by prairie plants.

Prairie plants are able to withstand all the many variations of climate and plant competition, having evolved in an environment in which wide fluctuations have caused frequent severe stresses. The major stress is lack of sufficient soil moisture, but this stress is not uniform for all plant species. Not all of the roots of prairie plants draw moisture from the same soil levels nor do they all use it at the same time. Species with more or less ephemeral tops may be rooted in the upper soil layers and may use moisture in quantity only before the grasses begin their heavy use. Such species then become more or less dormant and remain so until growth is resumed the next year. Others with short-lived tops and most of those that blossom later may have tap-roots that extend beyond the roots of grasses and so get at least part of their moisture below the zone where grasses compete. Still others are rooted in the same layers as the grasses and are direct competitors for moisture. Annuals, on the other hand, find the prairie environment difficult. Perennial plants exhaust moisture from the upper soil layers and the annuals are not able to extend their roots into the deeper ones. In climax prairie, annuals are effectively prevented from completing their life cycle, so they finally dwindle away, relegated to the disturbed areas along trails, eroded banks, rodent diggings, and the like.

The period of greatest deficiency in soil moisture in the prairie is also one of low relative humidity and high temperatures. Prairie forbs that normally blossom at that time of year may fail to do so in abnormally dry seasons, but the plants themselves are seldom killed or even seriously damaged by drought. Their ability to become more or less dormant enables them to live until favorable conditions recur.

Many forbs of the prairie are legumes; some are useful forage species that decrease under hard grazing just as do the dominant grasses. Their roots are generally well nodulated, thus capable of fixing atmospheric nitrogen which helps enrich prairie soils. Some of the showiest wildflowers of the prairie fall into this group.

Rather large numbers of prairie forbs, including some of the legumes, are poisonous, most of them only mildly so but others are quite toxic. Fortunately, most of the toxic ones are low in palatability and are taken by stock only in the desperation of hunger. It is also fortunate that, although many of the poisonous species occur in climax, they are not sufficiently competitive to become dominant. Many of them increase, however, under continued grazing that is heavy enough to reduce the vigor and competitive ability of the dominant grasses. Such heavy use could not continue in the natural state, because when feed supplies dwindled animals either were forced to leave the area or they succumbed to starvation in large numbers. That reduced grazing pressure and allowed vigor of the dominants to be restored before permanent harm could result. With restored vigor came restored competitive ability, so neither increasers nor

FIG. 4. Plains wildindigo (*Baptisia leucophaea*) blossoming where grass has been burned April 10, 1965. Note fresh new grass blades emerging at the base of the picture around the Baptisia plant. Photo by Kling Anderson.

invaders could ever offer any serious challenge to the dominant grasses.

The Indian knew and avoided toxic prairie species, although he probably used certain plant poisons for hunting, warfare, and perhaps medicines. Many plants that would be toxic in large doses served as medicines, real or fancied, when taken in small amounts. Prairie forbs supplied a wealth of medicinal materials for the Indian and for our early settlers.

Many species of prairie forbs were eaten by the Indian who had learned which roots, bulbs, shoots, and fruits or nuts were tasty and nutritious. He, or rather his squaws, spent much time gathering and preparing these various plants, some to be eaten in season and some to be stored for future use. Our early settlers also learned to use wild prairie plants for food, drink, and condiments, and modern Man continues to gather certain wild plants even today.

Many prairie forbs are highly palatable to grazing animals and are sought eagerly, at least at some stages of growth. They not only provide nutritious forage but add variety as well, and that may be of some importance in animal performance through possible micronutrients. It has been shown that animals with free access to grass and forbs gain more than those limited to grass alone.

Another important contribution by prairie forbs is the feed they supply to wildlife, significant amounts of herbage and much seed as well as nectar and pollen. Shelter too, is required by wildlife, and prairie forbs and shrubs help fulfill that need.

One of the important elements of the prairie environment is fire. Both grassland climates and grassland vegetation favor fire, and natural as well as man-made fires must have occurred with sufficient frequency in the prairie to have profoundly influenced evolution of both the plant species and the vegetation as a whole. As a result, a vegetation made up of plants highly resistant to damage by fire has evolved.

The Indian long ago discovered many uses for fire, among them warfare, communication, and hunting. He learned, for example, that game could be driven to its slaughter or to its capture by fire and that the new, fresh herbage which appeared after fire would attract grazing animals in large numbers. Small wonder, then, that prairie burning became a highly useful and widely used tool in his life and that the vegetation was subjected to far more burning than it had

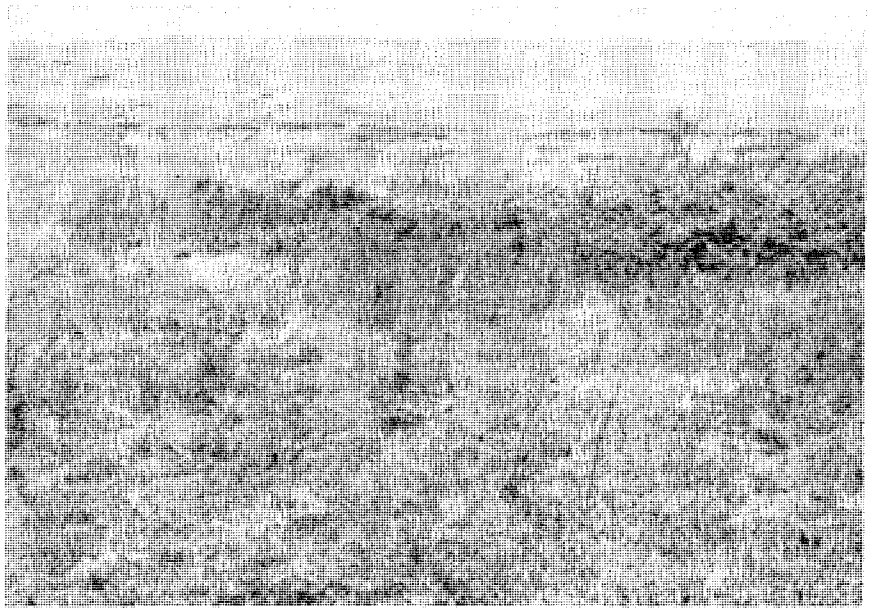

FIG. 5. A large clump of buckbrush (*Symphoricarpos orbiculatus*). The tops were killed where the stand was thin enough to grow grass for fuel for the fire. The thick stand at the center of the clump kept the grass reduced so that it could not carry the fire and this part was not destroyed. Photo by Kling Anderson.

been before Man appeared. The settler learned from the Indian and intensified the practice still further.

Not only are the grasses able to survive frequent burning, but most climax prairie forbs are equally persistent under fire. They have remained in the prairie despite repeated burning. Having evolved in an environment that included fire, they have considerable resistance to serious damage from that element.

Accidental range fires might occur when forb tops are green and thus have a direct effect through removal of living tops. Now most prairie range is burned before spring growth starts, in which case removal is limited to last year's dead tops. That has very little direct effect on forbs, but it will, of course, severely damage the stems of shrubs. Food storage is not affected, but new growth must replace the old stems. Thus shrub tops may be kept in a juvenile condition by annual burning.

Fires of this sort have a profound effect on soil moisture, allowing

greater runoff and evaporation. The earlier the burning, the greater the moisture loss, and the greater the chance to affect vegetation.

Not even the most vigorous proponents of burning range claim that fire benefits plants directly, but burning is a practice that can make range vegetation more easily accessible to the grazing animal and can make its utilization a little more complete. Thus, animals on spring-burned bluestem range gain a little faster at first and reach market condition earlier than those on similar but unburned range despite the somewhat reduced forage yields that follow burning. It may be necessary to allow a slightly greater acreage for each grazing animal following burning, but that does not decrease gains per animal, only per acre. Thus burning bluestem range must first of all be considered as an animal husbandry practice.

Fire might have a somewhat direct beneficial effect on certain seeds that it "scarifies" or that escape from fruiting bodies opened by heat, but the truly beneficial effects are indirect. A major one is related to differential resistance of plants to fire. Most climax prairie species, and especially grasses, are resistant to fire. Most annuals and many weedy perennials are killed or damaged by properly managed fire on bluestem range. Late spring fire may remove the green tops of early perennial weeds at or near their period of low root reserves, and that will damage them severely. It will prevent early annuals from seeding. Thus competition is reduced, and the less-damaged, or possibly even undamaged, climax species are permitted to thrive.

Other beneficial effects of range fires may be related to their impact on insects and diseases. Relatively little is known about this, but like plants, insect species may also respond differentially to range burning. If the picture is also affected by heavy grazing, as it so often is, the effects of fire may be observed. Certain destructive cropland grasshoppers, for example, invade burned, heavily grazed range. Grasshopper species found in climax grasslands, however, usually are harmless to farm crops and cause no damage to the range.

There is much to be said about prairie forbs, their place in the plant community, their various uses, peculiarities in their growth habits, the great beauty of many—the list is endless. Some of these facts will be brought out during the discussion of individual species, photographs of which are to be shown here today.