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WHITE MAN VERSUS THE PRAIRIE[1]

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THE prairie that I have in mind in this essay is that vast sweep of potentially natural grassland that stretches from the ninety-fifth meridian westward to about the one hundred and fifth meridian, and from Canada southward to the Rio Grande and the Gulf. The title suggests something of the nature of a contest in which the advantage may swing now toward one factor, and at another period the other may be favored. We are thus reminded of the ebb and flow of the rhythms that characterize so many of the phenomena of dynamic natural history.

Much of the thrill that helps to compensate the scientist, in his constant search for truth, comes from the contemplation of the natural cycles that appear on every hand. Man himself is a composite rhythm of precariously complex balances, as indeed is the universe as a whole. Life and death are but two of the termini that mark the rhythmic phenomena of the cosmos. As Goethe wrote:

> The spectacle of nature is always new, for she is always renewing the spectators. Life is her most exquisite invention, and death is her expert contrivance to get plenty of it.

During the past century scientists have clearly demonstrated that nature and time had played with inferior organisms of great variety in lapping waters and by muddy shorelines for hundreds of millions of years before man entered the dynamic landscape. Many of those early creatures had already gone the way of all dust because they failed to adjust their fundamental affairs to meet the rhythmic vicissitudes that have characterized the sweep of time. Primitive man, crude as he may have been, was "smart enough"

[1] Address of the retiring vice-president and chairman of the Section on Botanical Sciences, American Association for the Advancement of Science, Columbus, Ohio, December 28, 1939.

to conclude that he was the only true and all-powerful "Lord of Creation" to emerge from the cosmic whorl. It may be significant to note, in passing, that the contributions of those folks and their ilk to intellectual and social advancement have become more completely disarticulated than have their physical bodies. We find only a hunk of a skull, a fragment of the jaw, a single tooth or a few uncertain artifacts embedded in wind-deposited or water-laid sediments with which to construct our notions of them and their day.

Fragmentary evidence appears to indicate that a few wise men of all ages knew quite well how society should plan if man hoped to operate successfully and continuously within the mighty cycles that rule the universe. But it is true that those sages were sadly unsuccessful in their efforts to control the human greed, selfishness and the lust for power that tended to lead the races astray. Disappointment and disillusionment have followed in the wake of man's debauchery and his inheritances throughout the ages. In these latter days that we like to think enlightened, men shudder as they contemplate the wrecks of the past. We are bewildered when we behold the scanty vestiges of the lost civilizations that are uncovered in the sands of China. We are thrilled and then shocked into deepest humility when we stand in the presence of the crumbling palaces and splendid tombs of Egypt and Greece and Rome, now in large part mercifully enshrouded by the silt and sand of time.

Two thousand years ago an unusual farmer boy lived in northern Italy. That young chap was aware of much of the hidden and practical ways of nature, especially those that are close to the land. Virgil recorded many of his observations of natural phenomena in those classics known as the "Georgics." He protested against the senseless waste of natural resources. He sought to teach that there is dignity in labor upon the soil, and that there is strength and happiness to be found in a closeness to nature. He was a mighty good farmer. Listen, for instance, to a bit of his advice regarding the utilization of land as it is told in the first "Georgic":

> But ere we stir the unbroken ground,
> The various course of seasons must be found;
> The weather and the setting of the winds—
> The culture suiting to the several kinds
> of seeds and plants, and what will thrive and rise,
> And what the genius of the soil denies.

The ancients did not follow the urge of the early men of vision in the sensible utilization of the natural bounties so richly bestowed upon them. Fragmentary mementos of worn-out and buried civilizations have marked those lands for centuries. The Incas and the Mayas have vanished. A few wind-strewn relics on a mountainside and the wrecked piles of magnificent temples in a tropical jungle are intriguing evidences of their fundamental blunders.

Viewed against the background of human history, or the more spacious landscape that portrays the interlocked rhythms of the natural history of Mother Earth, it is only this morning that the *Mayflower* docked in Plymouth Bay—only last night that the foundations of Jamestown were laid. The colonies could vision faintly, if at all, the incredible treasure of forest and prairie, of wild life, of clear streams and spacious skies that spread ever westward. It was quite proper for them to fell the pines and spruces, the sturdy oaks and elms, to build their homes, and fashion the ships with which they won their freedom. Land must be cleared of forest, and grassy intervals must be plowed to care for expanding settlements.

That was all as it should have been. No one will take issue with the colonists, or with any person or group since those stirring days, in their efforts to utilize the wealth of the primeval resources of America. It is against the lack of thrift and the ruthlessness and waste which have marked such activities that we must complain. Notable warnings were raised from time to time by various early patriots (as of old). The good advice of Penn and Washington went unheeded. Jefferson pointed out that "fields are no sooner cleared than washed." Patrick Henry warned that "since the achievement of our independence, he is the greatest patriot who stops the most gullies."

Long before the American colonists made their first clearings Virgil foretold (in the second "Georgic") the devastation, destruction and doom, which haunt even dumb beasts, that regularly follow the thoughtless, selfish efforts of man in the exploitation of a nation's wild resources. Listen to the words of wisdom from that ecological farmer of the first century B.C.:

> The like of forest land is understood
> From which the spleeful Ploughman grubs the wood,
> Which had for length of ages idle stood.
> The birds forsake the Ruines of their seat,
> And, flying from their nests, their callow young forgot,
> The coarse, lean Gravel on the mountain sides,
> Scarce dewey Bev'rage for bees provides. . . .
> . . . Happy the man, who studying Nature's laws
> Thro known Effects can trace the Ancient Cause.

As a nation and as individuals we have blundered, like the vanished races of earth, in the utilization of our primitive wild-life resources. We have been little concerned about the balances of nature which, if severely disturbed, may bring disaster to large blocks of society. We have boasted too much of our inexhaustible supplies of earth's native goods, and of a growing mastery that gave us every right to *win* in the conquest *against* nature and time. This situation has, of course, become widely known, especially in so

far as the forest is involved. The axe and the saw and the forest fire played their parts in the disturbance of the balance of one of our major biological swings. An aftermath of worthless brambles, blackened ghosts and gullied slopes mocks us from millions of acres where once nature perfected the amazing forest. The nation is just now learning that white man has also continued to function as the blatant beast of the wasted prairies. It is pitiful to what extent enlightened society has sounded the discordant note in this wild American symphony—a composition that one hears best in the shadowy aisles of the virgin forest or on the broad sweep of the open prairie at sunset.

A hundred years ago the population pressure of the forested lands in the east turned white man's face toward the western prairies. The new migration was dominated by the same restless, romantic, ruthless spirit that had characterized the earlier pioneers. Long after the colorful decades of the colonial period white man spread toward and over the far-flung land of gentle grassy knolls, ravines and sweeping plains with the same all-engulfing enthusiasm with which he had breezed through the forests of the earlier day. The contest of white man versus the prairie was on.

The rolling expanse of virgin prairie, a thousand miles wide, was indeed a formidable barrier to the westward march of settlement. Only men with the reckless spirit that developed the 6-shooter or those driven by an overwhelming religious zeal, such as the Morman pioneers, dared risk the terrors of the long trek into or across that uncertain belt of grassland. The effort was richly charged with adventure and often spiced with romance. We still enjoy the colorful tales that tend to portray the exhilarating but precarious life of the pioneers of the prairies.

In picturesque vehicles and with characteristic impedimenta their caravans snaked across the wild ravines of waving grasses and flat plains of kinky sod to the foothills of the Rockies. They thronged to the battle on a thousand fronts. Uncounted divisions enlisted to win the virgin richness of the prairie from Mother Nature, and to turn her treasures to the creation of another huge "empire" of "man's own making." Cattlemen followed the trappers and the frontiersmen. Farmers hurried westward in the wake of the herdsmen. Bison and Red Men fell by the wayside. Crawling caravans of settlers from the East flocked into the land of meadow larks and Andropogons. We told the world about the golden riches that were hidden in the loamy soils of the prairie. A little later the iron horse reared up the ravines and over the divides, ever westward, to relieve the winding trails and the dusty ruts of the prairie schooners. The deer, the antelope, the prairie chicken and the bob-white went the way of the buffalo and the Indian. Along with the settlers came trees, feathered creatures and sophisticated crops, the like of which the prairie had never known.

As a small boy on a Nebraska farm, toward the close of that fascinating period, we were thrilled with the spirit of the times. Many the bleak wintry nights that we dreamt of the cunning schemes of a Red Cloud and the last desperate thrusts of a Sitting Bull. The very air was electrified with primitive human activities. We labored in our childish way to help to pay off one mortgage, only to inherit a larger one. Life was full, and the fine wild things of nature were close, so varied, so abundant. The rich odor of freshly turned soil, the fragrance of the wild plum blooms and prairie roses were not yet contaminated by highway aldehydes, creosotes, packing-house stinks and what have you!

We shared personally, to a small degree, in the breaking of those prairie sods, from which states have grown. The trim, low plow with its gracefully turned mouldboard and the long, sharp lay, the sturdy mules forward and the stalwart boy aft, was a common institution of the prairies in those days. The keen, diagonal blade of the breaking plow scored a snipping symphony with the roots and rhizomes of the prairie grasses and their associates. Those plants were the children of species which nature had been perfecting on those soils since Tertiary times! The long, tough spirals of sod flowed backward from the glistening plowshare in an unbroken band, and settled, upside down as a continuous, plank-like record of man's conquering (?) march.

Then came the selfbinder, the riding gang-plow, the tractor, and with those instruments, the urge for more acres (and more mortgages). Great carpets of tall prairie grasses and kinky short grasses were turned on an ever-widening front to the westward. An abundance of moisture at the time, and practically free land, stimulated a rapidly extending settlement and intensified the efforts to reap the rich harvests from the newly acquired dominion on the "lone prairie."

White man took the prairie too blithely, as earlier he had taken the forest. What he did not appreciate was that, although man may turn the sods and plant the grain and trees, it is only God who sends the raindrops. Man failed to envision the prairie as one of earth's astounding examples of an infinitely complicated biological rhythm that had been evolving in that domain since the Tertiary. He was slow in learning that the virginity of the prairie had been established through long ages of travail and that the wild things that he saw there were an infallible index of what was best, in the long run, for such a place. He failed to sense the danger involved if he dared to cross nature's tenacious tendencies with radical schemes for utilizing the native range and introducing the crops of the humid East.

Many mistakes were made, but, in general, all went

well for years or at least periodically. Came sizzling summers and frigid winters, that alternately seared the bodies and froze the souls of those hardy men. Thousands of them fled. After periods of indescribable misery, the rains came again, the "climate changed" and another boom was on. The survivors trustingly enclosed their home grounds and fields with belts of cottonwoods, ashes, bois d'arc and maples. More cattle and more sheep spread over the treeless range-lands that seemingly flowed to the setting sun. More sod was turned, more crops sown.

And so it continued from cycle to cycle. In spite of severe chastisement by the recurring biological upsets, the prairies continued to evolve new barons of meat and wheat. The all-conquering lords became more and more megacephalic and ventricose gibbous. They had just about completed the conquest of man against nature throughout the rolling horizons of the American prairies when, in 1933, Mother Nature once more, and quite suddenly, appeared to play her long-accustomed part in another roundup. Men had not yet understood how treacherously narrow was the margin of safety within which they had practiced their arts in "conquering" the prairies. Nature began once more to number the raindrops. There were not enough of them for the thirsty fields of maize and wheat that man had placed where once were species whose conditioning dated from an earlier age. Succeeding crops were pitifully poor. Failure was common. Trees from the humid forest bowed their leafy heads, gave up the struggle. Their decorticated trunks stand as ghostly reminders of man's folly. Even the hardy prairie grasses and the ubiquitous ruderals that had crept into openings in the prairie sod were badly weakened or completely obliterated. The cattle and sheep in sunny dells and on a thousand breezy hills nibbled the dwindling grasses and upstart weeds. Cloven hoofs and sweeping blasts of earth dissected the last surviving crowns and added their mangled forms to the swirling, black clouds that were swept up from the precious top-soil. Fallow fields of powdery soil had replaced the flowing grain, the lush pasture and the grassy range.

The reactions from white man's incisive invasion of the prairie had so disturbed the long-established and well-ordered rhythms in the good earth that the fingers of nature caught up the soil and flung it at the sky. Indeed it could then be said:

> The hills were shadows, and they flow
> From form to form, and nothing stands;
> They melt like mists, the solid lands,
> Like clouds they shape themselves and go.

On and on whirled the choking dust in a widening cloud, a veritable black blizzard that blotted out the light of day and buried white man and his eroded trappings under the stifling pall. The atmosphere was laden with millions of tons of the choicest surface soils. The dust swept onward, ever eastward, until it settled upon the White House and was gathered into the humid oblivion of the Atlantic. The latter day storms of vaporous earth must, indeed, reflect something of the cosmic magnitude and severity that marked the period of loessial deposits.

Bad as the situation has been, as related to wind erosion, there are other severe aspects of White Man's insistence upon conquering the prairie. We may refer to the wide-spread destruction of land and other property, and the loss of hundreds of lives caused by floods in various parts of the nation, including the prairies. We are impressed by the sincerity of purpose and the vigor of the interests that investigate such calamities and endeavor to find means to forestall their recurrence. In the most of these efforts it is somewhat disconcerting, however, to note the scanty attention that has been given, until lately, to the biological conditions far back on the various watersheds that contribute to the inception of floods and dust storms.

Tremendous losses were suffered in southwestern Nebraska in the early summer of 1935 because of flood waters that swept through the Republican River section of the prairies. Since that time the area has been the focus of considerable attention, not only as looking toward the prevention of further damage by water, but because of the period of severe drought, toward the possibility of impounding the waters of the stream for irrigation. In all this agitation little concern has as yet been expressed for certain significant features of the ecological set-up that prevailed (and still prevails) on the upstream slopes of the river for many years preceding the devastating flood of 1935.

For a long time white man had been an active party (more or less unintentionally) to the crippling and ruination of the wild prairie that stretched over the drainage area of that stream. Years ago we noted the progress of those modifications of the rhythms of the prairie which contributed in no small degree to the development of conditions that culminated in that disaster. The prairie sod had been severely disturbed over wide expanses by breaking, overgrazing, fire and possibly by earlier droughts. Even in districts where the sod had not been turned by the plow, there were then huge stretches of land that were dominated by pepper grass, sunflowers and other hardy weeds. The plant population had been severely reduced in density and virility and the soil was essentially bare in many places on the uplands of the Republican watershed.

There was little upon the face of the earth in that area to shield the powdery soil from the initial attacks of the falling torrents of rain that began late in May,

1935. The surface of the soil was so dry and fine that the drops could not force themselves into it. Rivulets of brown water rapidly grew in volume as they sped to the lower contours. Soon, under continued precipitation, the gully-washer stage was reached. From boiling gullies to raging, relentless flood water was but a moment in the story. The mighty force of the once precious, but now treacherous liquid uprooted trees, displaced bridges and buildings, inundated farms, flooded cities and spread the hush of death over the valley. From a genesis so simple and unimpressive on the upstream flats and gentle slopes the water was rapidly transformed into a destroying demon that left terror along its route.

But, you ask, what is white man to do about it?

First of all, we must learn that Mother Nature is not a nudist by choice. If left to her own ways, she will clothe herself in a lovely smock of forest trees, or at least in a sarong of prairie grasses or weeds. I have been intimating that man, for thousands of years, has been running away with her clothes so persistently and so completely that she has had the greatest of difficulty to preserve her modesty.

Perhaps the egocentric complex that has for so long time dominated White Man in his attitudes toward nature and her primitive ways has finally felt the impact of such shocking experiences that we, in America, may pave the way for better times. It would seem, in spite of the blotted and grimy picture of the past, that such an opportunity is still open to us. Certainly, if we do not mend our ways, we shall witness the continued spread of frightful ugliness over the land.

There are, at last, hopeful signs that progress is to be made toward the formulation of a more enlightened program to guide our ambitions in the future. Numerous well-endowed institutions and individuals are turning their best abilities toward such efforts. To aid in the discovery and clarification of what may be done to preserve such balances among the major natural rhythms that the perpetuation and continued improvement of nature's abundant bounties may be insured, is certainly an objective that is as rich in spiritual returns as it is bristling with the challenge to science.

Reputable biologists do not claim that the maintenance of a cover of forest trees or prairie grasses or fully cropped fields on the upstream slopes and over vast sweeps of prairies and forests will prevent floods and dust storms at all times and under all conditions. We must admit that man is helpless to tame the rain clouds and the continental winds or to build the rocks and renew the hills. We boast of impressive works in the form of dams, levees and revetments that tend to protect against the flood waters. Seldom, however, do we pause to analyze the primitive biological phenomena that are commonly associated with the earlier droplets of water or whisks of dust that gather over the denuded ridges and slopes or fallow fields far back from the raging flood and the settling dust. Perhaps if we insisted upon a saner plan of settlement and utilization, the expenditure of modest sums would be sufficient to accommodate those first little units of water and earth, from which the flood and the dust bowl may develop.

It is fine, of course, for the engineer to lay obstacles across the path of the flood, but most such works are designed primarily to care for the flood waters when they arrive down stream. I would plead for more interest in the ecological relationships of the outer areas of the watershed where erosion really begins and over which waters and winds may gain their destructive volume and momentum. If White Man would maintain and improve the natural means of absorbing the raindrops where they fall and hold them in the woodlands, the prairies and the fields where they are so sorely needed, their rapid and destructive coalescence might be prevented or so greatly reduced that floods and dust storms would not menace him. It would seem that a good place to begin the study of erosion is the place where erosion begins.

White Man may exert great influence in the steady maintenance of a cover of vegetation on the land. He may plant and he may sow, and he may aid Nature in such a manner as to improve the complicated biological character of the soil. Students in my own department have proved (in a modest way) that even a scanty cover of plants profoundly increases the absorption of falling water, and at the same time greatly reduces the volume of water that drains from the land. A few grasses or even a light cover of cultivated plants soften the blows of the falling raindrops and surprisingly reduce the amount of suspended and dissolved material that is moved from the land by water. Runoff on a 5° slope, from 12.9 inches of rain that fell in eleven months was 1 per cent. from the prairie, 12.1 per cent. from a wheat field and 17.8 per cent. from fallow land. And no measurable erosion occurred from the prairie, while 0.52 tons of soil per acre was carried from the wheat field, and 2.6 tons from the fallow area. Runoff resulting from the fall of 3 inches of rain in 1.5 hours on a 7° slope was nil from prairie, but 20 per cent. from broken prairie planted to corn for six years. Such differences holding over a large catchment basin might readily represent the difference between severe floods and no flood at all. It has also been demonstrated that the tangle of rhizomes and roots of prairie grasses that permeate the soil to many feet beneath the surface serves as a mighty obstacle in the way of soil dissection by the erosive force of water and wind. The maintenance of some such barriers throughout the nation's forests, prairies and fields would seem to be imperative when

we are told that water and wind remove not less than 3 billion tons of soil from our croplands and associated pastures alone every year.

But I am not to tire you with the quotation of statistics or the recital of experimental data and conclusions. I would merely insist that White Man should cease to boast of having *conquered* nature. That is an important lesson that we should sense from the severe and recurring demonstrations that continue to prostrate mankind. Certainly the advantage in the contest of White Man versus the prairie in North America in the past several years has been with those superhuman forces that made and that tend to preserve the prairies inviolate. One of the major problems that now faces man throughout the world is to preserve what is left of his heritage in the soil, and to restore the broken lands that have dogged his footsteps through the forests and across the prairies for centuries.

VITAMIN K

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DURING the course of some experiments on the sterol metabolism of the chicken, Dam[1] (1929) observed that chicks raised on certain artificial diets became anemic, had large subcutaneous and intramuscular hemorrhages and that in one chick the clotting time of the blood was markedly increased. This striking hemorrhagic condition and prolonged clotting time were also observed by McFarlane,[2] *et al.* Although Holst and Halbrook[3] did not mention the impairment of coagulation, they observed the hemorrhages and reported their disappearance after the addition of fresh cabbage to the diet.

Continuing his work Dam[4] reported that the hemorrhagic condition was not relieved by the addition to the diet of vitamin C or any other of the known vitamins or essential dietary factors. He suggested that the hemorrhages and prolonged coagulation time were due to the lack of a new fat-soluble factor, which he named "vitamin K," from the Scandinavian and German term "Koagulations-Vitamin." This terminology has been accepted by other investigators in the field, but with the isolation of two compounds possessing vitamin K activity subscripts were added to K for purposes of designation.

Beginning in 1935, many important reports on the distribution, extraction, assay and chemistry of vitamin K have been published by Dam and his collaborators and by Almquist and his group of investigators. It is unfortunate that space limitations prevent us from referring to several of these publications.[5]

[1] Dam, *Biochem. Zt.*, 215: 475, 1929; 220: 158, 1930.

[2] McFarlane, Graham and Richardson, *Biochem. Jour.*, 25: 358, 1931.

[3] Holst and Halbrook, SCIENCE, 77: 354, 1933.

[4] Dam and Schønheyder, *Biochem. Jour.*, 28: 1355, 1934.

[5] Since the main purpose of this report is to set forth the present status of the vitamin K problem, an extensive review of the subject has not been attempted. The experimental work has been reviewed by Dam (*Ztschr. f. Vitaminforschung*, 8: 248, 1938–39) and clinical work by Smith, *et al.* (*Jour. Am. Med. Assn.*, 113: 380, 1939) and Butt, Snell and Osterberg (*Jour. Am. Med. Assn.*, 113: 383, 1939).

SOURCES OF VITAMIN K

Dam[6] and coworkers showed that the antihemorrhagic factor is widely distributed in green leaves and vegetables with an abundance in dried chestnut, spinach, cabbage and alfalfa leaves. Almquist and Stokstad[7] reported in 1935 that the addition of 0.5 per cent. of dry alfalfa to the deficient diet prevented the appearance of symptoms, and from that time alfalfa has been one of the main sources of the vitamin. Recognition of a different antihemorrhagic factor resulted from the observation of Almquist and Stokstad that rice bran, fish meal and other foods which had been stored in a moist condition developed vitamin K activity. That this production was due to the action of micro-organisms was definitely concluded from Osterberg's[8] work, which showed that large amounts of an antihemorrhagic substance were produced by bacterial putrefaction of fish meal, and from the report (Almquist, Pentler and Mecchi[9]) that a large number of different bacteria, including *B. coli*, were able to synthesize a substance having vitamin K activity.

BIOASSAY

Since progress in the vitamin or hormone field is dependent upon the detection and quantitative measurement of the active principle, several groups of investigators, Dam, Schønheyder, Almquist, Ansbacher and Thayer,[10] have devised bioassay procedures for

[6] Dam, *Biochem. J.*, 29: 1273, 1935; Dam and Schønheyder, *Biochem. Jour.*, 30: 897, 1936; Dam and Glavind, *Biochem. Jour.*, 32: 485, 1938.

[7] Almquist and Stokstad, *Nature*, 136: 31, 1935; *Jour. Biol. Chem.*, 111: 105, 1935.

[8] Osterberg, *Proc. Staff Meetings Mayo Clinic*, 13: 72, 1938.

[9] Almquist, Pentler and Mecchi, *Proc. Soc. Exp. Biol. and Med.*, 38: 336, 1938.

[10] Dam and Glavind, *Biochem. Jour.*, 32: 1018, 1938; Schønheyder, *Biochem. Jour.*, 30: 890, 1936; Almquist and Stokstad, *Jour. Nutrition*, 14: 235, 1937; Almquist and Klose, *Biochem. Jour.*, 33: 1055, 1939; Ansbacher, *Jour. Nutrition*, 17: 303, 1939; Thayer, McKee, Binkley,