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Forest Clearance in the Stone Age

During the Neolithic period the hunters of northern Europe gradually became farmers. Using their tools and methods, Danish investigators have re-enacted how they cleared the land and cultivated their crops

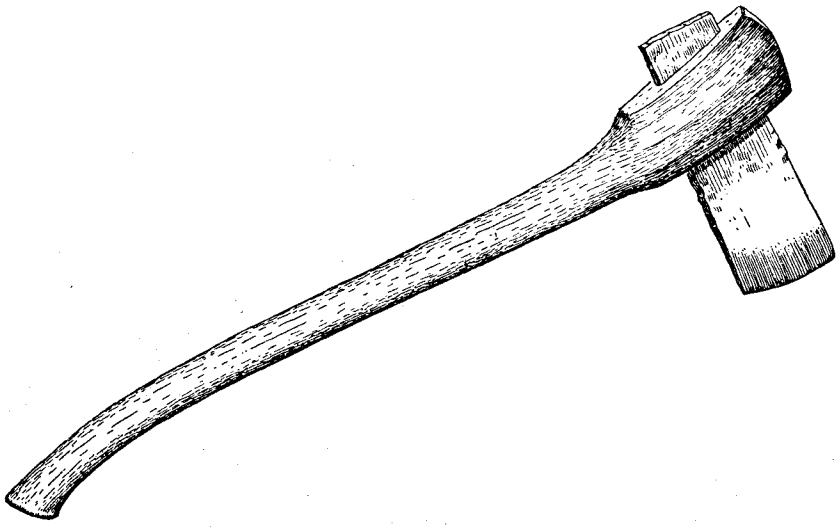
by Johannes Iversen

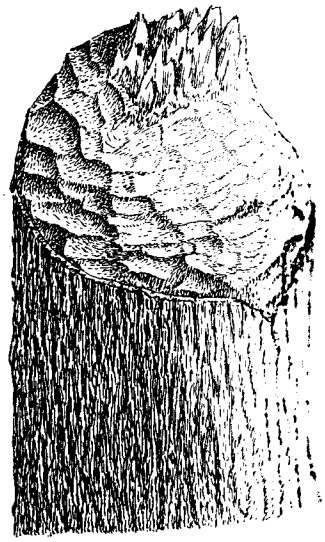
Perhaps the greatest single step forward in the history of mankind was the transition from hunting to agriculture. In the Mesolithic Age men lived by the spear, the bow and the fishing net; in the Neolithic Age they became farmers. The change came independently at different times in diverse parts of the world. Just how and when men turned to farming in Western Europe has been a subject of debate among naturalists and archaeologists for a hundred years. New methods of dating the implements of Stone Age men have recently given more factual substance to the debate. What is more, we have learned enough about the world in which they lived to test our theories about how they lived by experiment. This is a report of a set of experiments by which a group of scientists in Denmark attempted to re-enact some aspects of the hunting-to-agriculture chapter of mankind's past.

Denmark has unearthed relics of both stages—the bone and flint implements of the Mesolithic hunters and the polished stone axes of the Neolithic farmers. And in ancient lake sediments and bogs the prehistoric tools lie in recognizable strata of pollen, that marvelous dating instrument which identifies each period by its prevailing vegetation. The pollen record, as ecologists read it, tells the following story.

Toward the end of the last ice age, when vegetation was emerging and the country was still open, hunters ranged all over Denmark. Then, as forests grew dense and reduced large game, men abandoned the forested interior and retreated to the coast, where they made their living by fishing and seal-hunting. This state of affairs continued for thousands of years, until man suddenly appears in the forest, hacking out a new living. Clearings are hewed in the primeval forest. Tree pollen rapidly declines in certain regions, and we find in its place a sharp rise in pollen of herbaceous plants and the emergence of cereals and new weeds, notably plantain—the plant which the Indians of North America called "the footsteps of the white man."

Very shortly a new growth of tree species which typically follow forest clearance—willow, aspen, birch—springs up. The presence of birch strongly suggests that man used fire to help clear the forest, for on fertile soil birch succeeds





STONE AXE was reconstructed by mounting the Neolithic flint head on a copy of a Neolithic haft preserved at the bottom of a bog. It was found that the full swing of the modern woodsman often chipped or broke the head. Using short, rapid strokes, the experimenters learned to fell trees more than a foot in diameter in 30 minutes. To fell small trees they chopped all the way around the

a mixed oak forest only after burning. Meanwhile the ground flora undergoes a radical and significant change. Grasses, white clover, sheep sorrel, sheep's-bit and other pasture plants take the upper hand. We can visualize cattle grazing and browsing in grassy meadows bordered by scrub forests of birch and hazel.

Finally comes a third phase. The grasses, birch and eventually hazel decline, and a big-tree forest takes over once more. Oak now is more dominant than before; elm and linden never recover the strength they had in the primeval forest.

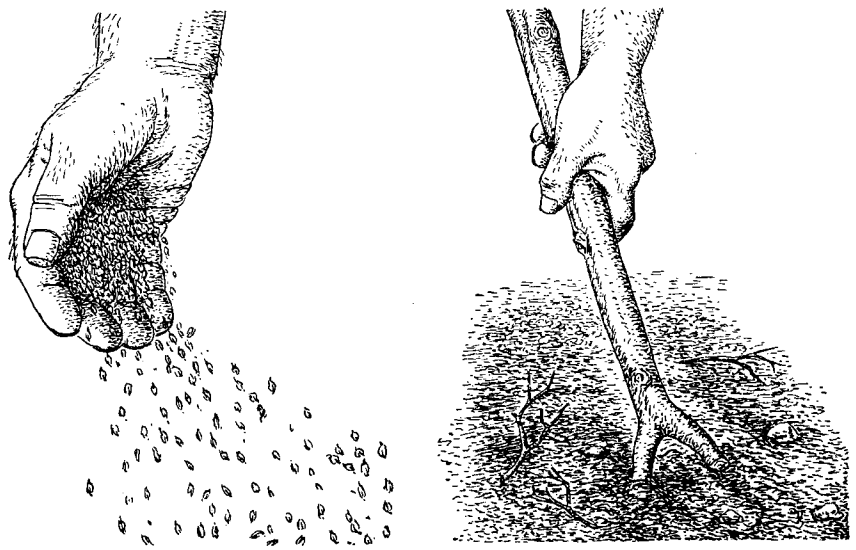
All this seems to mean that men cleared large areas of the original forest with axes, burned over the clearings, planted small fields of cereals and used the rest for pasturing animals. Their colonization was of short duration: when the forest grew back, they moved on to clear a suitable new area. According to the pollen record, some of their settlements can scarcely have lasted more than 50 years.

Now this is a neat, tidy theory, but there are troublesome questions. Could Neolithic man really have cleared large areas of the thick primeval forest with his crude flint axes? Could he have burned off the felled trees and shrubs in his clearings? Our team of ecologists and archaeologists decided to put these questions to the test of field experiment. We obtained the needed funds and permission to clear a two-acre area in the Draved Forest of Denmark, which is a mixed oak forest like that of Neolithic times.

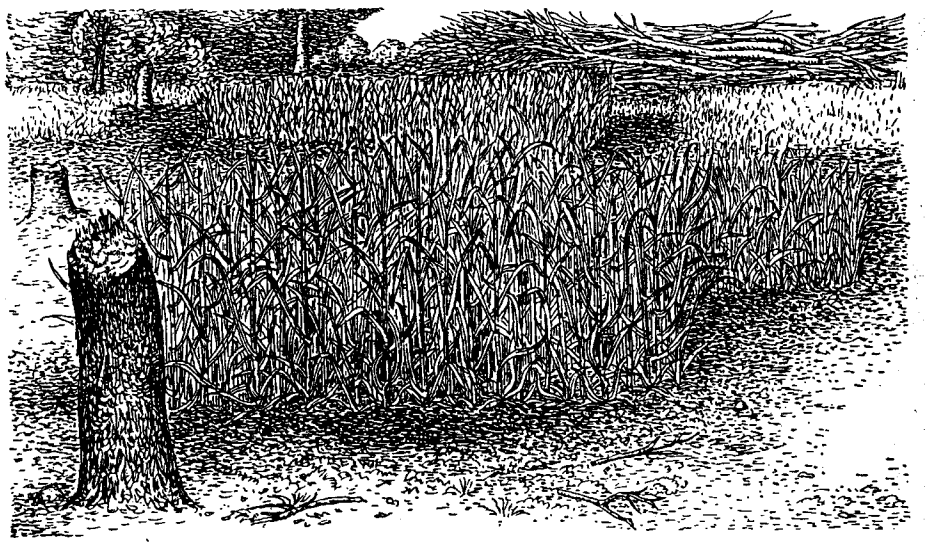
Two archaeologists, Jörgen Troels-Smith and Svend Jörgensen, took charge of the axe tests. They were able to obtain a number of Neolithic flint axe blades from the National Museum in Copenhagen, and a model for the wooden haft was available in the form of the famous Sigerslev hafted axe excavated from a Danish bog. In Neolithic axes, whose hafts were of ash wood, the blade was inserted in a rectangular hole in the haft [*see drawing on opposite page*]. Jörgensen and Troels-Smith demonstrated that if the haft was not to be split, it must not hold the blade too tightly but must leave room for a little sidewise play of the blade when it struck.

After making a number of hafted axes fitted with Stone Age man's blades, the two archaeologists, together with two professional lumberjacks, went forth into the forest in September, 1952. When the party attacked the trees, it soon became

TREES WERE BURNED by covering them with brushwood and igniting a 30-foot strip. When the strip was almost burned out, the larger logs were used to light the next one.



SEED WAS SOWN by hand in the still-warm ash (*left*). Then the seed bed was raked with a forked stick (*right*). The plants sown were barley and two primitive varieties of wheat.



BARLEY HAD GROWN to this height six weeks after it had been sown in the ash of the burned brushwood and trees. Barley sown in plots not covered with ash grew very poorly.

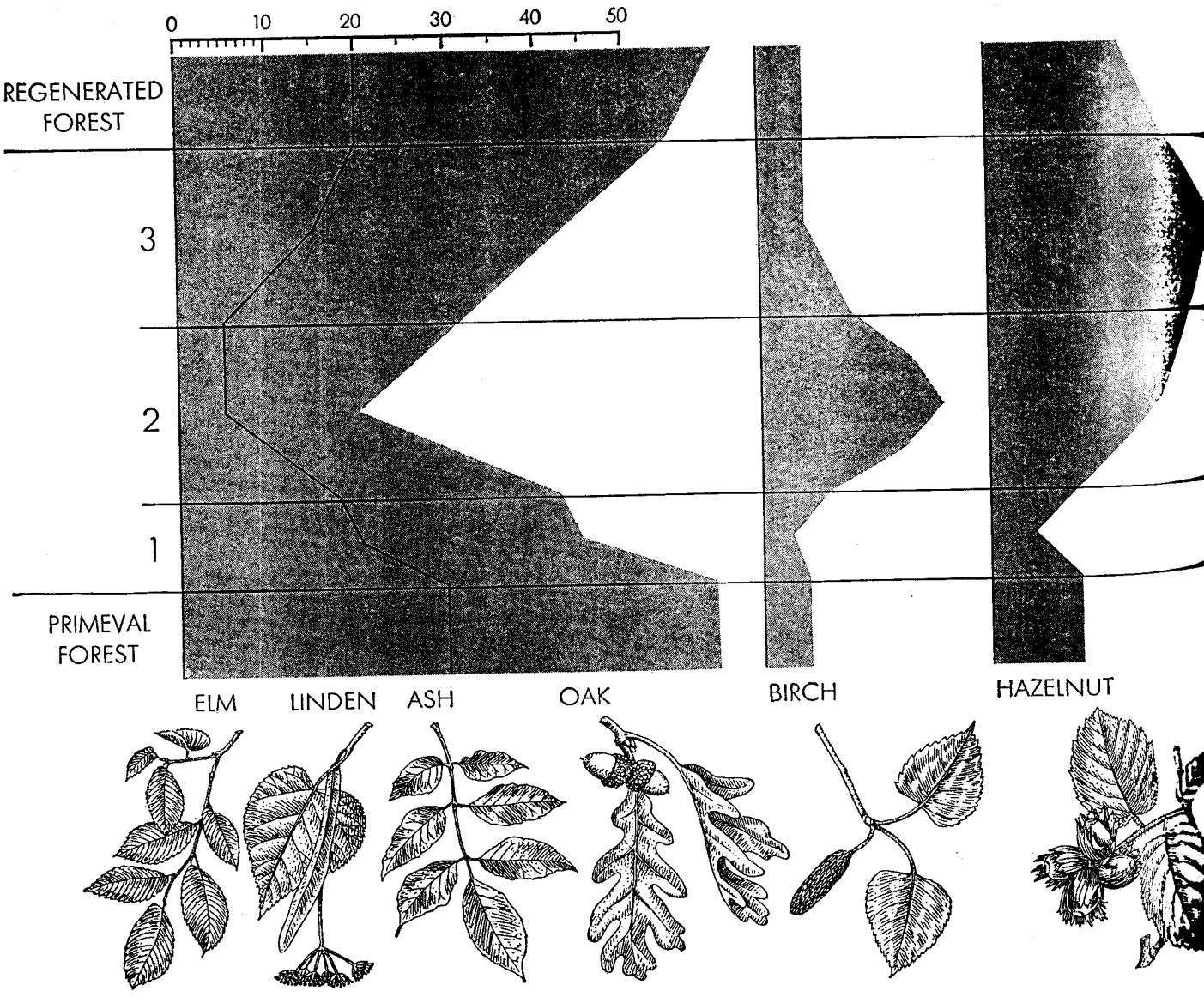
apparent that the usual tree-chopping technique, in which one puts his shoulders and weight into long, powerful blows, would not do. It often shattered the edge of the delicate flint blade or broke the blade in two. The lumberjacks, unable to change their habits, damaged several axes. The archaeologists soon discovered that the proper way to use the flint axe was to chip at the tree with short, quick strokes, using mainly the elbow and wrist. Troels-Smith, working with an axe blade which had not been sharpened since the Stone Age, employed it effectively throughout the whole clearing operation without damaging it.

When the two archaeologists reached peak form, they were able to fell oak trees more than a foot in diameter within half an hour. Small trees they dropped by cutting all around the trunk; on substantial-sized ones they used the slower method of hewing through notches on the opposite sides, in order to control the direction of fall. We realized that for clearing purposes it would be advantageous to have all the trunks lying in the north-south direction; for example, the wood would dry more quickly.

In this manner we cleared the two acres of forest, letting the largest trees stand but killing them by cutting rings through the sapwood. Troels-Smith and Jörgensen concluded that Neolithic men could have cut large clearings in the forests with their flint axes without great difficulty.

The next problem was to learn how they might have burned off their clearings. For help in this phase of the experiment we called on Kustaa Vilkuna of the University of Helsinki, who is an expert on primitive burning techniques which were still being used quite recently by farmers in the spruce forests of Finland.

Without waiting for the wood to dry, we first tested two burning methods, one modern, the other primitive. The modern method, though effective in forests of conifers, failed completely in our deciduous forest. The primitive method, how-

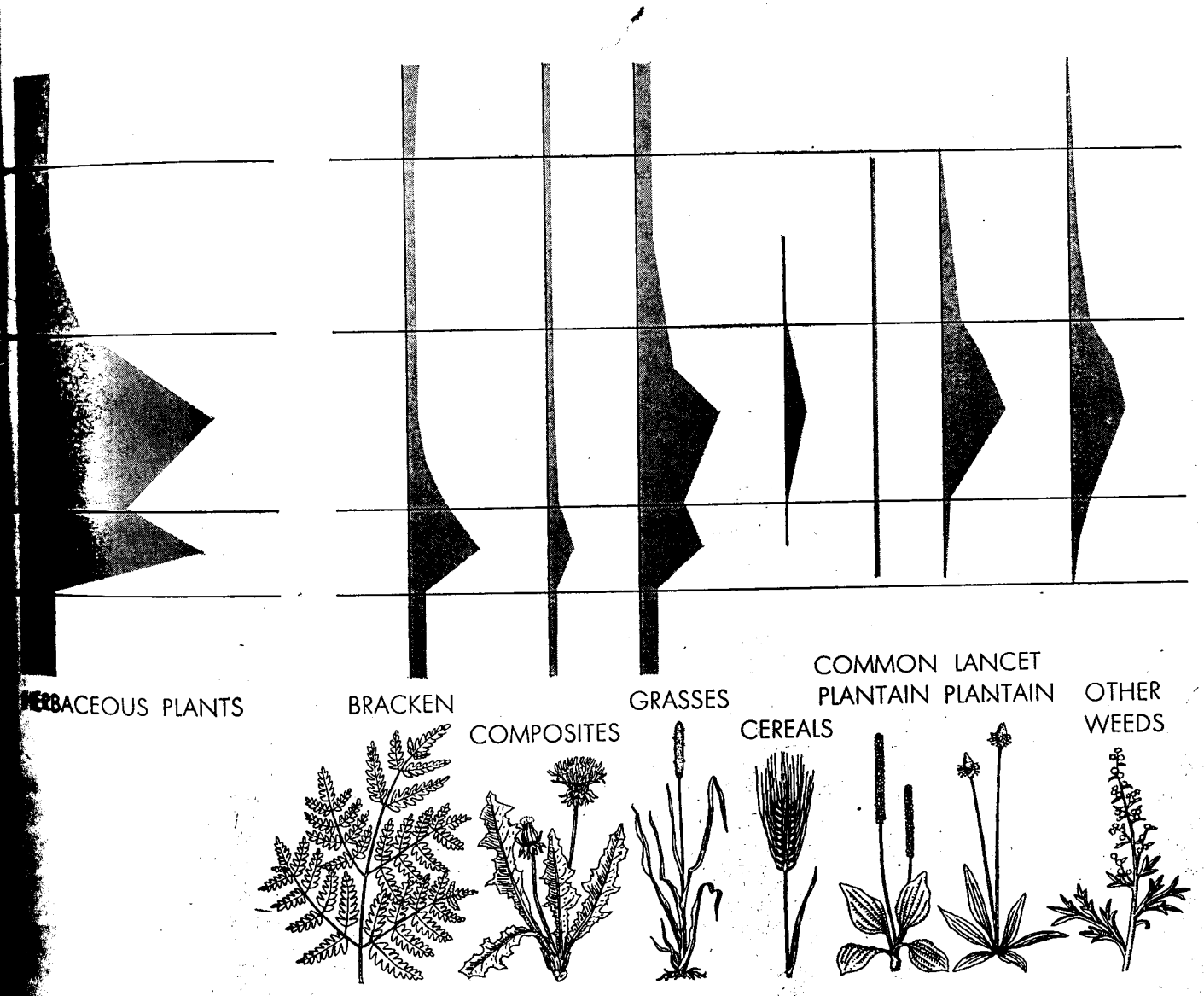


POLLEN DIAGRAM shows the effect of forest clearance on the vegetation of Denmark between about 2500 B.C. and 2300 B.C. The diagram is based on many samples of pollen taken by boring down into bogs. The width of each colored area on the diagram represents the proportion of pollen from one species in comparison to that from all others. The scale of the proportions is given at the

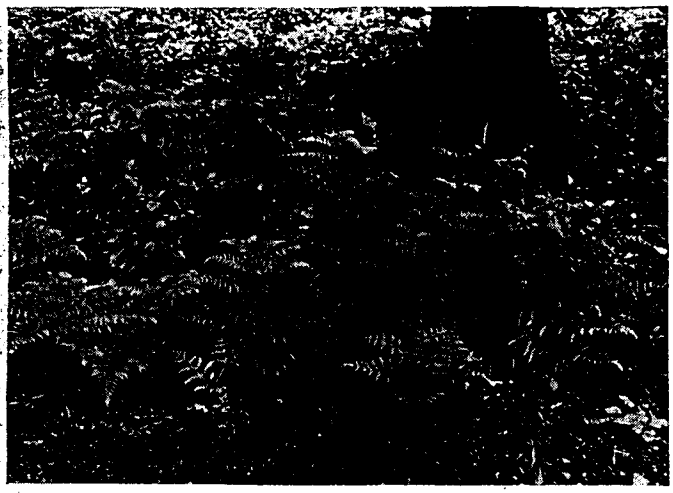
ever, was successful, and we proceeded to use it in the clearing in May of 1954, after the felled trees had had more than a year to dry. Brushwood and branches cut from the trees were spread over the area to be burned. Then this material was ignited along a 30-foot-wide belt by means of torches of burning birch bark attached to stakes. When the belt was well cleared, we pushed its still burning logs forward with long poles to set fire to the adjacent area. In this way we burned off the tangle of felled vegetation belt by belt. The fire was controlled carefully, day and night, to achieve an even and thorough burning of the ground. It was rather hard work, as oak wood burns slowly, but there were no serious difficulties, and in three or four days the job was finished. We burned only half of the two-acre clearing, because we wished to compare the subsequent growth on burned and unburned ground.

Immediately after the burning we sowed part of the area with primitive varieties of wheat (einkorn and emmer) and naked barley. That these cereals were grown in Denmark by Neolithic man is shown by grain impressions on excavated pottery. Axel Steensberg, an expert on agricultural methods, old and new, obtained seeds of the cereals from botanical collections and directed our agriculture.

We spread the seeds on the ground, raked them in with a forked branch, and waited for the harvest. For comparison we sowed two sets of plots—one burned and one unburned but hoed and weeded. The contrast in results was remarkable. On the unburned ground the grain scarcely grew at all. Evidently the rather acid forest soil was not suited to cereal growing. But the burned ground produced a luxuriant crop (which Steensberg harvested, in Neolithic fashion, with a flint knife and a flint sickle). The success of the cereals in this ground was due in part to sweetening of the soil by the wood-ash and the absence of competition from other vegetation, but the burning may also have created other beneficial factors, and we are now investigating this matter. In any case,



upper left. In the primeval forest (*colored areas below the bottom horizontal line*) the distribution of pollens was 30 per cent elm, linden and ash; 30 per cent oak; 5 per cent birch; 10 per cent hazel, and so on. During the three stages of forest clearance (*1, 2 and 3*) the distribution of pollens changed. The distribution of herb pollens is shown at the right of the break in the horizontal lines.



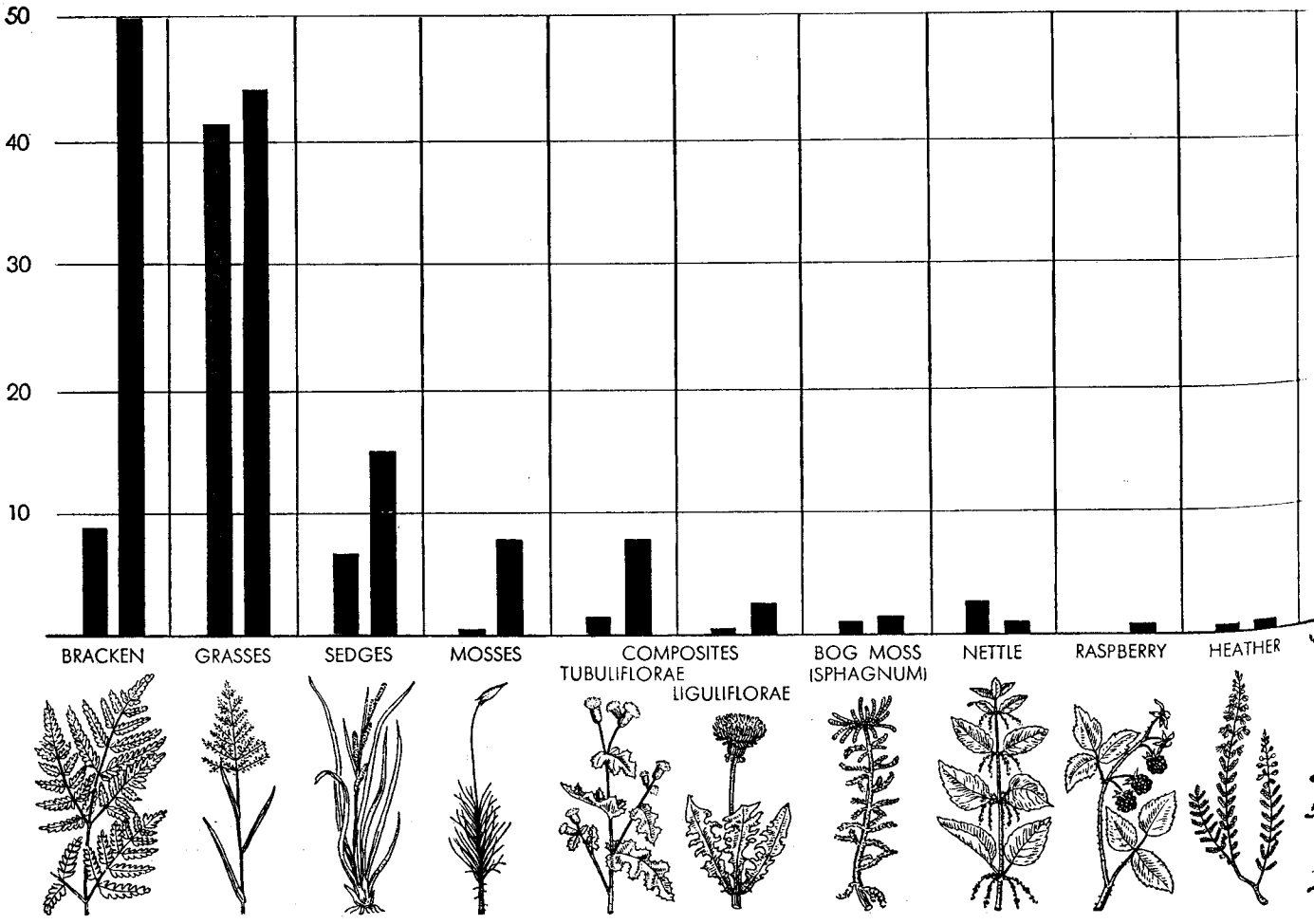
NEW COMMUNITY OF WILD PLANTS grew up in the parts of the clearing that had been burned over. At the left is a species of fern called bracken. Second from the left is hazel. Both of these plants had been present in the original forest. They grew up again

whatever the factors are, they are short-lived, for the second year the burned plots yielded much smaller crops.

Now, two years after the clearing and burning, we are in the process of watching developments in the early recovery of natural plant growth. The burned and unburned areas are developing quite differently.

In the area cleared of trees but unburned, events are following an unsurprising and unexciting course. The ground vegetation consists mainly of the species that grew there before the clearing, though it is growing more luxuriously because it has more sunlight. Bracken (ferns), always abundant in this part of the world, is flourishing far more richly than when it was shaded. Grasses and sedges have increased.

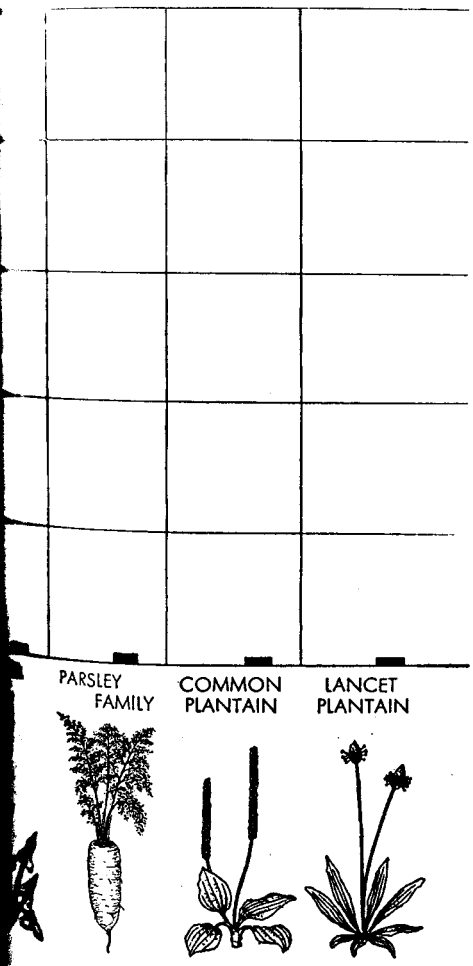
The burned ground, on the other



NEOLITHIC COMMUNITY OF WILD PLANTS that followed clearance and cultivation is analyzed in this pollen diagram. The colored bars indicate the amount of pollen from each plant before clearance. The black bars indicate the amount of pollen after clear

from relatively deep roots. Third from the left are dandelions, members of a family which grows in profusion under such conditions. Fourth are mosses, which had never been seen in this forest before. Their spores were blown into the clearing on the wind.

hand, is a scene of botanical revolution. Bracken is coming back here too, but most of the other old plants, having shallower roots, were killed off by the fire. In their stead we have a whole garden of new plants. Plantain has made its appearance, just as it does in the ancient



ance. The scale at the left is based on grains of pollen per 1,000 grains of tree pollen.

pollen record after forest clearance. There is a profusion of members of the family *Compositae*, including dandelions, daisies, sow thistle and so forth. (These plants do not bulk large in the fossil pollen record, but that is understandable because they are pollinated by insects rather than by the wind.)

A particularly interesting development is the sudden appearance of mosses and their spread over large patches of the burned area. The main species have never been seen in this forest before. Their spores have flown into the clearing on the wind, and no doubt mosses came the same way to the areas burned by Neolithic man. What makes them especially significant is that certain mosses seem to be definite indicators of fire; three species have been so identified in America, and sure enough the same three appeared in our burned clearing. Since the moss phase in a burned forest must be ephemeral, moss spores in the fossil record should enable us to pinpoint the dates of forest clearance by Neolithic man and to learn whether they burned the same clearing more than once during the existence of a continuous settlement. Unfortunately the small moss spores are difficult to recognize, and analysts of the ancient pollen deposits have not counted them hitherto. We made a small test count at the site of a Neolithic forest clearing in Denmark, analyzing the layers representing the time of the clearance and the period just before. According to our fragmentary count, there was a sharp rise in general moss growth (we made no attempt to distinguish individual species) immediately after the clearance of the area [*see chart at the left*].

Our experimental clearing in the Danish forest is just beginning to pass into the second phase, when pioneer trees appear and the regeneration of the forest commences. Birch seedlings are starting to spring up in profusion; willow seedlings have appeared; and hazel, aspen and linden shoots are rising from roots that were not killed by the fire. We are looking forward to studying this gradual regeneration in the years to come, as well as to reliving the stage in Neolithic farming when men grazed their cattle on the re-emerging ground vegetation.

Meanwhile we can say that so far our experiment has confirmed the archaeological interpretation of the pollen record on several important counts. It has been demonstrated that the forest could indeed have been cleared by the primitive tools of Neolithic man, and that in the first stage at least the reviving vegetation follows a course very like that deduced from the ancient pollen layers.

Of course man's transition from hunting to farming may well have taken other paths besides the one we have traced in the Danish clearings. More than one type of agriculture may have existed simultaneously in Denmark. As a matter of fact, Troels-Smith has found evidences of a more primitive agriculture during the same period on the Danish coast, where the Middle Stone Age men apparently cleared no forests but practiced a little crude farming along with their hunting and fishing.

The Neolithic farming culture described in this article is so much more advanced, and begins so suddenly, that it seems to signal the arrival and invasion of a vigorous new people from another region.