plants completely dead. The great majority had green shoots growing from the main stems or their branch limbs. Only a few cases were observed where the green shoots were growing from twigs or from the crown only. In one case, that of a mesquite nearly ten inches in diameter, all the branch limbs were dead, and the thrifty green shoots from the main trunk were fast filling the vacant spaces between the dead limbs.

On a later visit, November 24 to 26, into the Virgin River Valley, particular attention was paid to the creosote bushes in several places, near Hurricane, Washington, Santa Clara and the Beaver Dam slope, all in Utah (altitudes 2,500 to 3,000 feet). These observations confirmed the previous conclusion that the large majority of the plants had suffered frost damage, but in no observed case was the plant entirely dead. The thrifty green shoots of the summer had, however, so grown that the dead portions were nearly inconspicuous, and the plants had so far recovered as to present an almost normal appearance.

It would seem then from these limited observations that at the places investigated along the lower portions of the Virgin River Valley the frost damage to the creosote bush was considerably less than was originally anticipated by Cottam. The plants exhibited a variable ability to resist the prolonged cold, some escaping almost uninjured, some receiving moderate injury and a few being killed down to the crown. All the plants examined showed a remarkable "comeback" from the damage.

The limits to the Lower Sonoran are abruptly reached in the foothills surrounding the Virgin River Valley, these limits being set by increasing altitude about 500 to 1,000 feet above the valley floor. Presumably the valley floor is so far down in the Lower Sonoran that the unusual cold would not be sufficient to permanently transform its vegetation, and Utah would be in no danger of losing its Lower Sonoran zone. It would be interesting to know, however, whether the cold spell was instrumental in shifting the upper limit of the Lower Sonoran downward. Would the extra cold concomitant with the 500 to 1,000 feet rise in altitude be sufficient actually to kill the more susceptible plants. This point does not seem to be settled by the observations. If some of the plants were killed, were there enough to move the limit or were there enough of the more resistant plants left to maintain the limit? If there is any shift at all in the limit of growth of the creosote bush the fluctuation would probably fall within very narrow limits, as would be expected where the limits are set by altitude instead of latitude.

A. M. WOODBURY

UNIVERSITY OF UTAH

FOREST WILDLIFE AND SILVICULTURE[1]

IN this informal talk this evening on "Forest Wildlife and Silviculture," it is my intention by way of introduction to touch briefly on the broad topic of forests and forest wildlife and then turn the attention of the group to one specific phase of this broad subject which bears closely on silvicultural problems.

We have all heard a great deal, particularly in recent years, of the role that forests play in wildlife production, particularly in the production of game birds and animals, grouse, turkey, deer, elk and the forest's importance in the production of fur-bearing animals, beaver, mink, marten and others almost too numerous to mention. Undoubtedly this phase of the forest wildlife picture is an important one and justifies the attention it has been given. It is a field which presents many interesting and difficult silvicultural problems bearing on wildlife which I wish by no means to minimize. Certainly the present wide division of opinion on whether or not timber production and wildlife and recreation can be combined on the same area or whether some areas must be devoted strictly to game production, some to recreation and still others to timber production, is a land-use problem of great moment and one on which we need a great deal of additional information on what various silvicultural practices will mean in terms of wildlife. The problems on this side of the picture might be summed up in the question: "How do forests affect wildlife?"

It is the reverse of the picture, "How does wildlife affect forests?" to which I would like to turn your attention at this time. This is a much less discussed field. The principal characters in the drama, if you will, are not the noble elk or the empire-building beaver, but such lowly creatures as the white-footed mouse, the chipmunk and the squirrel. But the story is an interesting one to the biologist, nevertheless, and one of importance from a silviculturist's standpoint.

Now if my biological audience will permit me—what is silviculture? One of the lesser known and least practiced of the arts, mainly the art of tending forests, including methods of establishment, their care during growth, their harvesting at maturity. In other words, the silviculturist occupies the same rich field in forestry that the agronomist occupies in agriculture—he is interested primarily in the art of crop production. The problems are, of course, very different in many important respects. The silviculturist must deal with a natural vegetation unit of exceedingly great biological complexity, consisting often not only of a diverse mixture of tree species but numerous shrubs, herbs, fungi, insects, animals and a complex

[1] Presented before the Biological Society of Washington at the 853d meeting, October 16, 1937.

soil flora and fauna. These organisms interact on one another and on their environment and are acted on in turn. In a normal mature forest the various biotic factors are usually in reasonably good balance. But if this balance is greatly disturbed, and this the silviculturist must do in the process of harvesting the timber crop, then we must know what we are about if disaster is to be avoided.

Accordingly, it is the period immediately following the timber harvest—the critical regeneration period—with which the silviculturist is most keenly concerned. What changes can and must be made in the micro-environment and how will these in turn affect regeneration of desirable tree species, the food supply of forest animals, the environment of the flora and fauna of the forest floor? Certainly clear cutting, at one extreme, will make marked changes in the micro-climate of the cut-over area, while light tree selection, consisting of the removal of only a few scattered trees per acre, may have little or no effect. In addition the silviculturist must frequently deal with lands previously devastated by fire or logging, more often a combination of these factors, which have created an environment for tree seedlings and other elements of the forest complex, including the forest animals, entirely different from those prevailing in the untouched stand.

In this critical regeneration period the seed or plant-eating rodent often plays a dominant role. Let me illustrate my point by a few examples of the type of thing I have in mind and some reference to its extent as we know it to-day:

Very frequently the silviculturist must depend on seed furnished by seed trees or adjacent uncut timber, to produce the new crop. In many types, for example, in the great ponderosa pine-Douglas fir belt running the length of the Rocky Mountain region, a great deal of seed is gathered by squirrels before the crop is opened and cached for a food supply. It is true that man in turn often robs these caches and uses the seed for growing planting stock or for occasional seed-spotting operations. But in normal or lean years the squirrels and chipmunks clean up the seed crop of the larger seeded species so thoroughly that natural regeneration is a failure. This is true in spite of the enormous crops of seed produced even in only fair to good seed years. Seed yields in western coniferous forests are frequently better than 40,000 seed per acre of the larger seeded species such as Douglas fir or ponderosa pine and several hundred thousand to even several million seeds per acre of small seeds, such as western hemlock or western red cedar. Seed which escapes the squirrels and reaches the ground is often gathered and stored or eaten by chipmunks and mice, though occasionally some of this is forgotten and the seed germinates to form a natural seed spot. Accordingly, throughout this immense region, the silviculturist must first devise a method to meet this rodent problem before other environmental factors can be considered. In general, satisfactory regeneration throughout this region requires a bumper crop so large that the rodents can glut themselves on it and still leave an ample supply for regeneration. This must be followed by a reasonably favorable season, so that a sufficient number of seedlings will survive the rigors of the critical first season.

This situation is by no means confined to the ponderosa pine type. Rodents and birds,[2] particularly juncos, through their influence on seed supply, also play an important and at times a key role in the adjacent coniferous forests of California and the Pacific Northwest. Not only do they destroy seed; they also feed extensively at times on newly germinated, succulent seedlings, thus encroaching further upon the supply available to restock the forest. In the Southern pineries birds play a particularly important role, the mourning dove, southern meadow lark, blackbirds and occasionally sparrows being the chief offenders. In natural regeneration rodents and birds if unmolested often play an important part in determining the composition as well as the abundance of the seedling crop through their preference for larger seeds and seedlings. They may destroy the entire crop of such large-seeded conifers as western white pine, ponderosa pine and Douglas fir, while smaller seeded species, cedar, lowland white fir, go unscathed and are more abundant as a result in the regeneration stand. In the South rabbits will eat and destroy slash pine and pass over longleaf pine in the early seedling stages. Although the role of these small forest inhabitants in their relationship to natural regeneration is best known in the West and South, they play a less known but undoubtedly influential role in other regions.

In addition, they play a dominant role in artificial seeding operations and are a major factor to be considered in the successful establishment of plantations from nursery grown stock. Direct seeding by man either broadcast or in seed spots, has been a patent failure almost anywhere in the United States where rodents and birds are not controlled or excluded. Planting operations—in both the nursery and field planting phases, suffer heavily from rodent depredations. Often rodents must be fenced out or controlled in other ways, before planting can be carried out successfully. When the snowshoe rabbit is abundant

[2] The role of rodents and other important forest and range inhabitants, is being studied intensively by members of the U. S. Biological Survey under the supervision of Dr. W. B. Bell. These investigations have proved extremely helpful, and most of the specific references herein to the role of important forest inhabitants are based on this work.

throughout the Lake States, for example, few plantations can survive satisfactorily without fencing or other protection. Horn tells us that direct seeding in the California pine region is hopeless unless the mouse population is held to less than one mouse per 50-trap nights.

These few citations serve to emphasize not only the importance but the widespread extent of the biological factor in silvicultural operations. No doubt other phases of it will come to our attention as time and resources permit the expansion of biological investigations to additional regions and problems.

The study of the animals themselves, their life habits and so on, are of course primarily the task of the forest biologist. Some of the questions which the silviculturist must put to the biologist are:

(1) What are the important forest-inhabiting animals and birds affecting forests and forest practices?

(2) What is their life cycle, their food habits, etc.?

(3) What effect will the destruction of other animals, including predators, have on them?

(4) How are they affected by environmental changes which the silviculturist may make—as through clear cutting, etc.?

The forester must have the answer to these and similar pertinent questions before satisfactory forest-cutting practices can be worked out in silvicultural terms.

I. T. HAIG

FOREST SERVICE,
U. S. DEPARTMENT OF AGRICULTURE

THE FORMALDEHYDE–PROTEIN REACTION

CLARK and Shenk[1] in a study of the action of formaldehyde upon proteins found evidence which they interpreted upon the basis of compound formation. This evidence, observed by x-ray diffraction methods, consisted essentially of two new interplanar spacings corresponding to values of 2.6 and 3.9 A.U.

The presence of these new diffraction rings in the case of fibrous proteins characterized by ready swelling in alkali (feather, hair, tendon) and their absence in proteins relatively inert to alkali (silk) was construed to be indicative of reaction at the amide nitrogen. The mutually perpendicular fibering of these new interferences in the case of fibrous proteins was considered as being in accord with this interpretation.

Subsequent work at this laboratory undertaken at the suggestion of Professor J. H. Highberger and in conjunction and agreement with experimental work on proteins at the United States Regional Soy Bean Industrial Products Laboratory at this university indicated, however, that the new interferences could be accounted for upon the basis of the polymerization of formaldehyde retained in the protein.

G. L. CLARK
R. ROWAN

UNIVERSITY OF ILLINOIS

BACTERIA IN DUST-LADEN SNOW

ON March 5, 1938, a snowfall occurred in the Ottawa district which brought down with it a considerable amount of solid matter sufficient to produce a distinct brownish discoloration. According to the Meteorological Division, Department of Transport, such winter dust falls are reported from time to time from certain stations in Northern Ontario and Quebec. The dust is believed to have originated in the Western States, a low pressure area centered over Arizona and Texas on March 3 to 4 having reached Michigan and Ontario on March 5. Carried at high levels the dust current encountered cold air moving west when condensation to snow brought the dust particles down.

Bacteriological analysis of samples, collected in open country previously covered by fresh clean snow, gave a count of 4,370,000 organisms per gram of deposit. Examination of plate colonies showed them to consist almost entirely of spore-forming types, only one non-spore-former, a micrococcus, occurring on the highest dilution plate of twenty-five colonies. *Bacillus megatherium* was the most abundant species. Others noted were *B. vulgatus, B. mesentericus, B. mycoides, B. simplex, B. cereus* and *Bacillus sp.* The predominant organisms encountered were thus types commonly found in soil and which might be expected to withstand well such adverse conditions as desiccation and low temperature.

A. G. LOCHHEAD

DIVISION OF BACTERIOLOGY,
DEPARTMENT OF AGRICULTURE,
OTTAWA, CANADA

SOCIETIES AND MEETINGS

THE NOTRE DAME SYMPOSIUM ON THE PHYSICS OF THE UNIVERSE AND THE NATURE OF PRIMORDIAL PARTICLES

A SYMPOSIUM dealing with the structure of the universe, cosmic rays and the ultimate constituents of matter and attended by more than 100 visiting scientists from 30 other colleges and universities was held at the University of Notre Dame on May 2 and 3, 1938. The symposium, arranged by Dr. Arthur Haas, comprised three public lectures and several technical sessions at which Dr. Arthur H. Compton, of the University of Chicago, Dr. Harlow Shapley, of Harvard University, Dr. Carl D. Anderson, of the Califor-

[1] *Radiology*, 28: 357, 1937.