American Forestry, Dec 1917 Vol. 23, No. 288

CLIMATIC RECORDS IN THE TRUNKS OF TREES

BY A. E. DOUGLASS

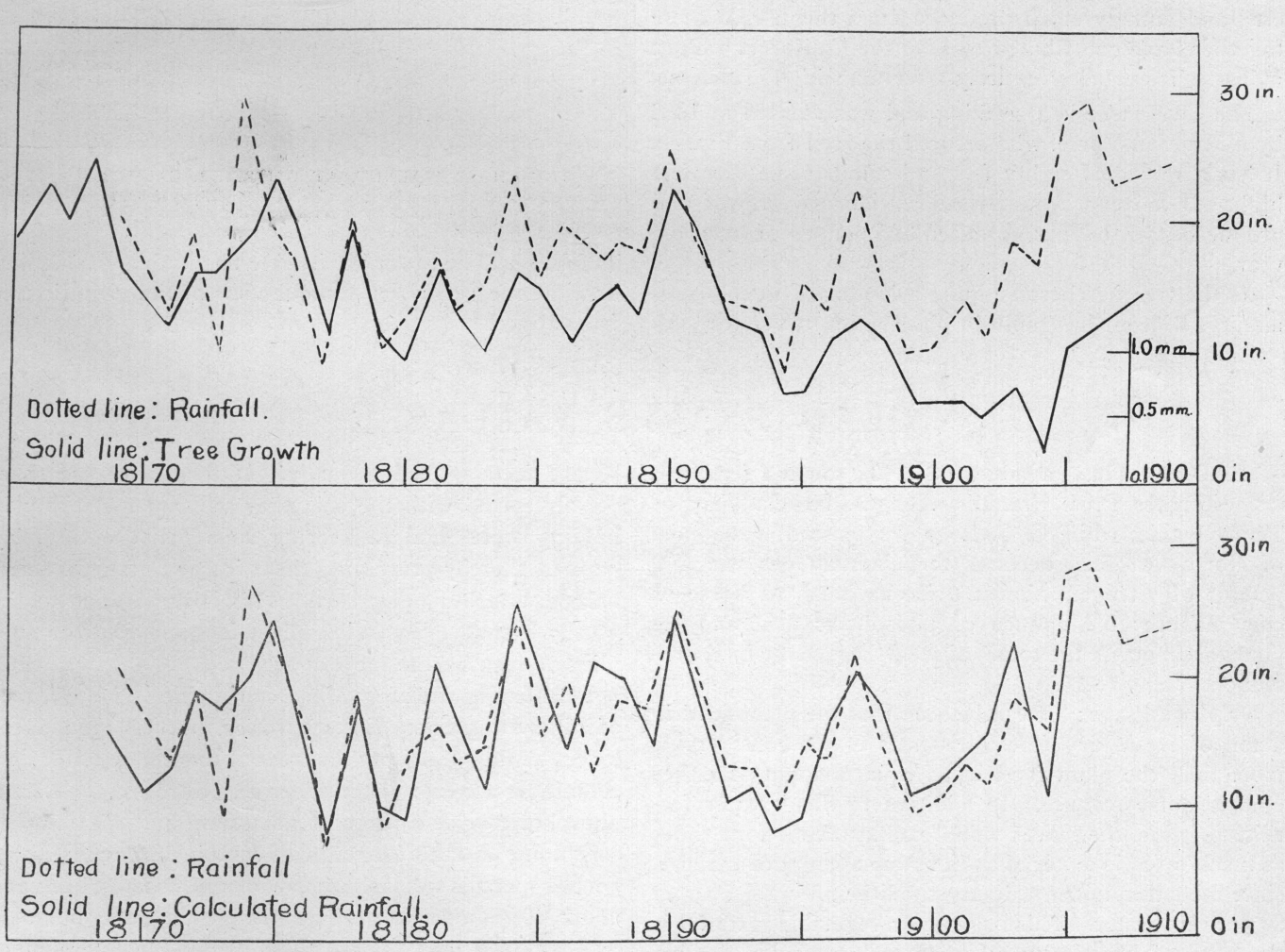
DEAN COLLEGE OF LETTERS, ARTS AND SCIENCES OF THE UNIVERSITY OF ARIZONA

THE annual rings of trees have been found to display in their varying width a life-long record of events historically important in the life of the tree. Such events naturally have to do with favorable or adverse weather conditions, interference by competing vegetations, shade, drainage, pests, fires, and so forth. Most of these effects are well known to the forester, thus the result of forest fire is a matter of constant observation. Smoke near great iron manufactories in diminishing the rings of trees has been studied with care, and numerous interesting photographs showing it have been published by the Mellon Institute.*

In the Geological Museum at Berlin one may see samples of pine, collected by the late Professor Potonie, some grown in upland and some in swampy ground, showing wonderfully diminished growth in the latter, due to the excess of water. The effect of drainage in wet climates is beautifully shown in a small section of *Pinus sylvestris* in the office of Professor Jelstrup, chief of the Norwegian Forest Service, at Christiania. This little section shows 17 rings of annual growth in a radius of 15 millimeters from the center. In that year trenches were dug draining the land and allowing the soil to dry in part. The remainder of the radius of the section is 40 millimeters in width, but contains only eight rings. The growth increased five and a half times after drainage.

But in the great fundamental questions of weather conditions, nature has constructed immense laboratories over the earth, some of which isolate effect of varied rainfall in a beautiful manner. In regions where the rainfall is really deficient, the tree makes a lifelong struggle against drought and, if other accidents are largely absent, that struggle is the most prominent feature of the rings. Even if the other factors are present, we must remember that the average of a group of trees, sufficiently scattered in location, will practically eliminate

*J. F. Clavenger, "Effect of the Soot in Smoke on Vegetation," Bulletin No. 7, Smoke Investigation, Mellon Inst., Pittsburgh, Pa.



COMPARISON OF 43 YEARS OF RAINFALL AND TREE GROWTH AT PRESCOTT, ARIZONA

Fig. 1—In the second diagram, the "Calculated Rainfall" is obtained from the Tree Growth by multiplying its value each year by three terms: First, a general coefficient changing mean tree growth to mean rainfall; second, a small factor correcting for age of tree, and third, a "conservation" factor to correct for preservation of moisture fallen in previous years. This conservation factor is very nearly the formula for "accumulated moisture" reversed.

state road. The dirt of a shallow fill which might have been otherwise disposed of was placed against the base of the trees, which became weakened by lack of root air and were attacked and killed by the pine bark beetle, to remain skeletons of desolation along this otherwise beautiful road.

A previous study of values and a plan for the careful preservation in course of road construction will do much to retain many values with very little additional cost, that will otherwise be destroyed.

There can be no question that a knowledge of landscape engineering will be of untold value to foresters doing constructive work. With the rapidly changing conditions in regard to forestry in this country, a knowledge of this subject will become more valuable to the practicing forester. I, therefore, feel that the forest schools should offer at least a short course in the subject.

A WONDERFUL WALNUT TREE

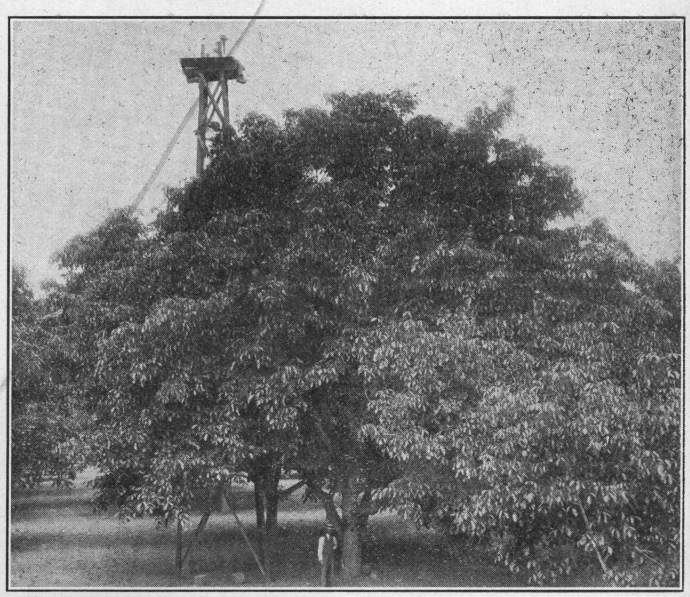
BY V. W. KILLICK

IN a crisis of a walnut blight epidemic, some time ago. A. R. Rideout, of Whittier, California, accidentally discovered a single tree in the orchard of Jacob Chase, three miles south of Whittier, which showed a remarkable propensity for resisting the blight disease. Rideout leased the Chase tree for a number of years, and by budding it to seedling nursery stock, produced the first "blight immune" variety of walnuts.

Rideout's success led other men to search for more specimens of blight immune trees. A few were discovered and nursery stock produced from them. All these together have contributed to save the California walnut industry from being entirely overrun with the disease

The Chase tree is a seedling and was planted in 1886 by a Mr. Van Vorce, who secured the seed from France. It has a spread of eighty feet and stands some fifty feet high. It is very symmetrical, a vigorous grower and prolific bearer, having produced 325 pounds of nuts last year.

As the tree has become quite a landmark to the community, Rideout has built an observation tower through its foliage. The tower is fifty-five feet high and, standing upon it, one gets a very unique view of the gigantic tree from above.



THE CHASE WALNUT, AT WHITTIER, CALIFORNIA
In a crisis which threatened ruination to the walnut industry in California, this was the tree which by careful budding produced the first "blight immune" walnuts.

DEAD LEAVES VALUABLE

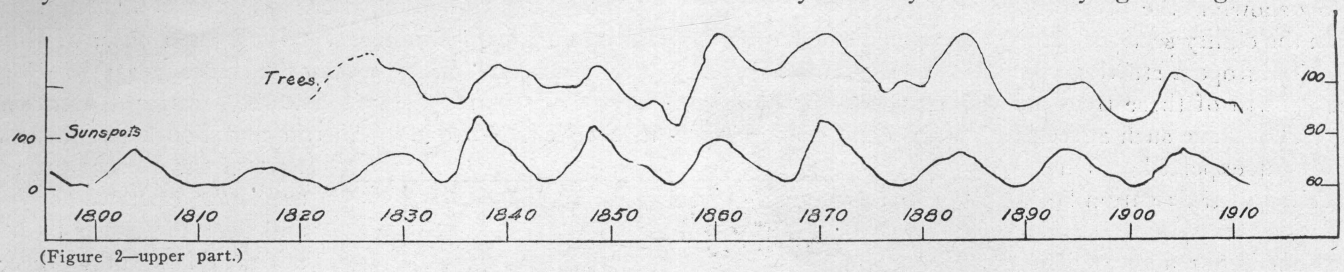
DEAD leaves have a value of $10.40 a ton as a fertilizer. estimates Prof. Franklin Menges, farm adviser of Pennsylvania, while C. C. Logan, extension agronomist of North Carolina, declares they contain per ton 15.2 pounds of nitrogen, almost twice as much as horse or cow manure; 5.2 pounds of phosphoric acid and 8.4 pounds of potash, the total value of these plant food constituents being $8.15.

Dr. Logan says: "It can be seen that the plant-food in a ton of fresh, dry forest leaves is worth considerable more than the plant-food in an equal amount of either cow or horse manure. In addition to this greater fertilizing value, the leaves would supply about four times as much organic material as the same amount of manure, since the latter, under ordinary conditions, contains about 80 per cent water. This organic or vegetable material is the need of practically all lawn and garden and most field soils of the state. The leaves, therefore, should be spread over such soils most in need of organic matter and be mixed in by plowing and harrowing during the fall or winter. A good rate would be 100 pounds for every 300 square feet, applied annually. If the leaves are thoroughly mixed with the soil, they will aid materially in holding water and in keeping soils moist during dry periods, thereby preventing them from running together, baking, and becoming hard. This is in addition to the goodly amount of valuable plant-food constituents supplied as seen by the table above."

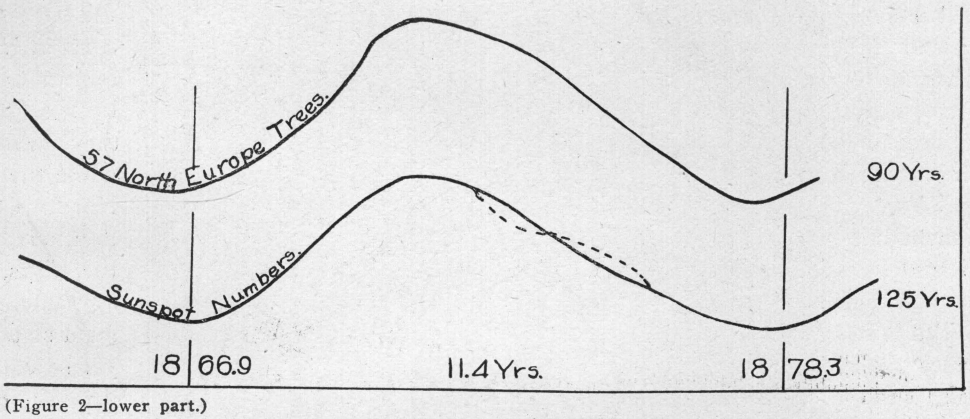
Dr. Menges declares: "The composition of the leaves of different species of trees varies, but 100 pounds of leaves as they fall from the trees at this time, partly dry, contain 60 per cent water, 9 per cent nitrogen, 2 per cent phosphoric acid, 4 per cent potassium and about 2 per cent lime. A ton of leaves will contain 18 pounds nitrogen, 4 pounds phosphorus, 8 pounds potassium and about 40 pounds lime. The nitrogen, valuing it at 40 cents a pound, would be worth $7.20, and the potassium at the same rate would be worth $3.20. Leaving the value of the phosphorus, the lime and the organic matter out of consideration, a ton of leaves would be worth at the abnormal prices now prevailing $10.40."

accidents of competition, injury and so forth and that other factors such as fires, drainage and sometimes pests, which themselves depend on weather, actually exaggerate climatic effects. Hence if in rigorous surroundings we can show empirically a relation between tree growth and terrestial or cosmic conditions, we are justified in regarding it as a genuine case of cause and effect.

Long residence in the great yellow pine forest of Northern Arizona led me to the study of that tree especially. In 1907 I had made and reduced ten thousand measures upon twenty-five long-lived trees. Four years later three or four thousand very careful measures upon the last fifty years of nearly seventy different trees were added. And now I have nine thousand more upon eighty different samples of the European *Pinus sylvestris* or common pine of North Europe. The conifers, by the great regions they cover, the great variety of climates they endure, and especially by the prominence of their rings, seem best adapted to this purpose.



(Figure 2—upper part.)



(Figure 2—lower part.)

COMPARISON BETWEEN 57 NORTH EUROPE PINE TREES (smoothed) AND SUNSPOT NUMBERS

The trees are from England, Norway, Sweden and North Germany.

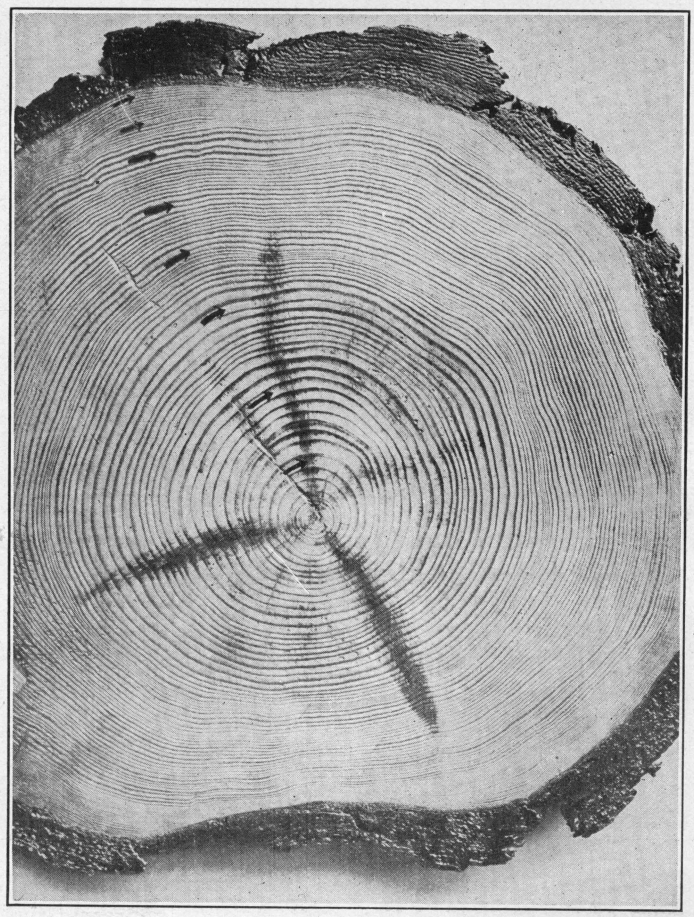
Apart from care in measuring the rings, the details of which have largely been described (Monthly Weather Review, June, 1909, and Bull. Am. Geog. Soc., May, 1914, Carnegie Publications, No. 192, Chapter XI.), the most fundamental and essential feature of the method is the cross-identification of rings among a group of trees. The ease and accuracy with which this can be done in a fairly homogeneous forest is remarkable. A group of thirteen tree sections collected along a distance of a quarter of a mile in the forest of Eberswalde, near Berlin, show almost identical records. Two to ten rings in every decade had enough individuality to make them recognizable in every tree. A group of twelve sections from Central Sweden, cut, however, from logs at the sawmill at Gefle, show such agreement that there is not a single questionable ring in the last hundred years or more. Especially marked combinations of rings could occasionally be traced across Europe between the groups hereinafter mentioned. In Arizona, identification across seventy miles of country was unquestioned and even at two hundred miles resemblance was apparent. But in Arizona trees the cross-identification was more essential, for in that region two causes operate to produce errors in ring counting; first, the strongly marked double rainy season (winter and summer) producing rarely an extra ring which resembles the annual rings; and second, the occasional series of deficient years causing some trees, in part of their growth at least, to stop ring production for one or more years. The error there of straightaway counting was found to average four per cent in the last two hundred years. By cross identifying all rings this error was reduced to half of one per cent or perhaps to zero. Recently I have made an interesting check on the accuracy of the accepted identification by noting every statement of weather, freshets or crop failures mentioned by the historian Bancroft in his accounts of the settlements of Arizona and New Mexico. I find fourteen cases in which the noted feature of the year agrees with the tree record, and but one doubtful disagreement. The most striking correspondences occur with reference to the flood on the Rio Grande in 1680, the famines between 1680 and 1690, and the droughts in Arizona in 1748, 1780 and 1821.

The accuracy with which the pine trees near Prescott, Arizona, represent the rainfall recorded in that city for forty-three years, is, without correction, about seventy per cent (Figure 1.) By a provisional correction for conservation of moisture by the soil, this accuracy rises to about eighty-two per cent. The nature of this conservation correction is very simple, it is practically the "accumulated moisture" of the meteorologists. It signifies that the rings in these dry climate trees vary not merely in proportion to the rainfall of the year but also in proportion to the sum of the profits and losses of the preceding years. The "credit balance" in their books at the beginning of the year has only somewhat less importance than the income during the current year. One must remember that conservation in this dry climate may be very different in its action from that in wet climates where the ground is continually moist or water-soaked.

In reckoning the amount of moisture for the year

one must remember also that precipitation in the form of snow goes over to the following spring growth and should be included in the rainfall of the succeeding year. Also in regions where there is a pronounced double rainy season, heavy precipitation in winter is necessary in order to tide over the spring drought, otherwise the tree may put on a false ring (usually easily distinguishable) or even in extreme cases stop growing for the year and show no effect of the summer rains. These features are finely shown in the Prescott trees.*

In the eighty sections recently examined or collected in North Europe a striking coincidence was found between the growth of these trees and solar phenomena (Figure 2.) That some such agreement should exist was not entirely unexpected. The question of the relation between sunspots and weather is one upon which doctors—and noted ones—have disagreed. This investigation was begun to see whether the trees, by representing the weather, would show such connection, if any exists. A very strong and very reasonable connection was found between tree growth and rainfall in Arizona. But also substantial evidence was found of a relation to sunspots. To give some idea of it one may say that in the last hundred and sixty years, ten out of the fourteen sunspot Maxima and Minima, have been followed about four years later by pronounced maxima and minima in the tree growth. Also during some two hundred and fifty years of the early growth of these trees they show a strongly marked eleven-year variation.



TREE SECTION, *PINUS SYLVESTRIS*, FROM NORTH GERMANY

Figure 3—The arrows mark the years of greatest sunspots. Note the periodic character of growth.

But in the very first group of European trees studied, those obtained at Eberswalde, near Berlin, the remarkable fact became at once apparent that these thirteen trees from one of those beautiful German forests, show the eleven-year sunspot curve since 1830 more accurately than do the corresponding curves of rainfall or temperature. The eleven-year variation in the trees is shown in the accompanying photograph of one of the Eberswalde sections (Figure 3.) It will be seen at once that there is a rhythmic sway in growth, large rings alternating with small ones. The arrows placed on the photograph are not there to call attention to the larger growth but to mark the years of maximum sunspots. The other twelve trees of that group do not show quite so perfect rhythm as this particular part of this section but are like the other parts of this section, showing strongly a majority of the maxima. Taking the group as a whole the agreement is highly conspicuous and the maximum growth comes within six-tenths of a year of the sunspot maximum.

In order to test further this coincidence, groups of tree sections were obtained from other parts of Northern Europe, namely, Southern England, outer coast of Norway, scattered places along the inner coast of Norway, Christiania, Central Sweden, scattered localities in Sweden, Northwest Austria and Southern Bavaria. Five of these eight groups are of the Eberswalde type and show the sunspot variation. Of the other three, the trees from the inner coast of Norway as a whole appear to show a reversed cycle, probably because they are deep inland valleys while the southern groups, Northwest Austria and Southern Bavaria, close to the Alps, have combined agreement and disagreement so that they cannot as yet be considered to give a definite result. In the six groups, however, representing the triangle between England, Northern Germany and the lower Skandinavian Peninsula, a variation in growth since 1820 showing pronounced agreement with the sunspot curve is unmistakable. Every sunspot maximum and minimum since that date appears in the trees with an average difference in growth of twenty per cent between them. This is shown in the diagram accompanying this article. The next most pronounced feature is that five of the eight minima show a small and brief increase in tree growth. This suggestion of a second maximum is of interest because in it we find agreement with Hann and Hellmann in their studies of European rainfall and sunspots and lend added weight to results which each author obtained but which neither allowed himself to regard as conclusive. In the splendid work of Hellmann upon the rainfall of the North German drainage area, it is this inconspicuous maximum which he finds the more important of the two.

In summarizing, two facts and a conclusion stand out prominently. First, it has been shown that trees may,

*See chapter by the writer in "The Climatic Factor," Carnegie Publications, 192.

and some in dry climates do, give a valuable record of annual rainfall; second, it has been shown that trees may, and some in wet climates do, give an excellent record of sunspot activity. Now, unless we introduce some new agency such as a profound changing stimulation in the direct solar rays, a subject well worth investigating, we must regard the trees as receiving their solar influence through the medium of the weather, and are forced to the conclusion that there is a connection of some sort between solar activity as displayed in sunspots and the weather, which by the aid of tree growth we have a most extensive means of investigating. Here then we are presented with a most fascinating field for future work. We must admit from the photograph and curves that there is a physical connection between solar activity and the growth of vegetation, certainly as represented in trees of certain districts. But the nature of this connection, through what weather element or elements it takes place, just how the sun affects those elements, even the exact causes of sunspots and why they recur in larger numbers every eleven years, are questions which will only be cleared up by extensive investigations.

One final practical word is well worth saying to lovers of forests. The account here given presents an idea of the value of records contained in trees. It is the oldest trees containing the longest records which are likely to die or be cut down first. So it is within the power of those having the care of forests, when the very old trees have to be removed, to preserve sections, marking them carefully with the month and year and locality, and thus preserve for future investigators, sources of information which, once lost, can never be replaced.

WHITE PINE BLISTER DISEASE

AT a recent meeting in Pittsburgh of the Committee on the Suppression of the Pine Blister Rust in North America about 30 representatives from the Department of Agriculture and various states and Canadian provinces were present. It was brought out that the blister rust is probably worse in Northern than in Southern Europe, and that it may, therefore, prove particularly destructive in the Northern United States and Canada. Dr. Spaulding, of the Office of Forest Pathology, stated that he believes the blister rust is more virulent on healthy, growing trees than on weaker ones. Wind is probably the main agent in distributing the disease, but birds and insects are also responsible. The disease is so firmly established in New England and New York, and probably in Ontario, as to make its eradication impossible. It is more widely distributed in the Lake States than it was a year ago, particularly in the St. Croix River Valley. So far as known, it has not been introduced in the western white or sugar pine regions.

NOT everyone knows that the first Pennsylvanian to really appreciate the value of forests was William Penn himself. In 1631 he provided that for every five acres cleared in Pennsylvania one acre should be left in woods.

DONATIONS TO THE LUMBER AND FOREST REGIMENTS RELIEF COMMITTEE

AMERICAN FORESTRY will publish each month the list of those making donations to this fund since the fifth of the preceding month. Practically all of the donations so far received have been made without solicitation and were inspired by reading in the magazine that a relief and comfort fund for the men of the forest regiments was to be started.

Contributions to and including December 5, 1917, are as follows:

W. R. Brown, Berlin, N. H.	$500 00
The Southern Lumberman, St. Louis, Mo.	25.00
L. H. Daloz, Boston, Mass.	12 00
L. F. Beigham, Chestnut Hill, Mass.	12.00
Wash. Heights Century Club, Wilmington, Del.	10.50
Cleveland Oconee Lumber Co., Atlanta, Ga.	10 00
John C. Freund, New York City	10 00
I. T. Beckwith, New York City	10 00
W. H. McElwee, Raleigh, N. C.	10.00
W. B. Marshon, Saginaw, Mich.	10 00
Clarence Hay, New York City	7 00
Mrs. T. M. Ives, New York City	7.00
C. I. McNair, Cloquet, Minn.	7 00
F. R. Thorns, New York City	7.00
Frederick R. Simms, Chislehurst, England	6.50
F. A. Chace, Fall River, Mass.	5.00
Dover, Del., Century Club	5.00
Newark, Del., New Century Club	5.00
Acorn Club, Seaford, Del.	5.00
Mrs. Wm. R. Cabot, Boston, Mass.	4.00
Miss Harriet Fearing, Baltimore, Md.	4.00
Miss Anna G. Bard, Huenema, Cal.	2 00
Mrs. James H. Beal, Boston, Mass.	2.00
Miss Bertha G. Brooks, New York City	2 00
Miss G. S. Cary, Boston, Mass.	2 00
Miss C. G. Curris, Intervale, N. H.	2 00
Mrs. Geo. H. Hosmer, Ithaca, N. Y.	2 00
Miss Lucy Lewis Hay, Philadelphia	1 00
Mr. and Mrs. J. H. Lesh, Newton Center, Mass.	1 00
Wm. S. Perot, Conshohocken, Pa.	1.00
Total	$687.00

THE FOREST FIRE SEASON

TAKEN as a whole, the forest fire season of 1917 has been the most serious throughout the West since 1910. Not since that year has the Forest Service been put to so severe a test. California escaped with less damage than the Northwest, where 7,688 fires were reported, entailing an expenditure of $1,825,000 for fire protection. In August the Governor of Oregon placed detachments of troops throughout the state where incendiary fires were prevalent, and closed the hunting season after it had been open for a week. In the State of Washington the forest fire wardens controlled bad fires at the expense of those responsible for their origin, a measure which was said to prove very effective.

THE California Packing Corporation of San Francisco was awarded the sale of 233,000,000 feet of timber on the Norval Flat-McCoy chance on the Lassen National Forest. Three bids were received, that of the successful competitor being 10 cents per thousand above the minimum. The prices to be paid are: For yellow, Jeffrey, and sugar pine, on the Norval Flat, $2.85; on the McCoy chance, $3.00; for fir on both, 50 cents per thousand.

THE WOODPECKERS

(Family Picidae)

BY A. A. ALLEN, PH.D.

ASSISTANT PROFESSOR OF ORNITHOLOGY, CORNELL UNIVERSITY

FEW birds are more easily recognized by the layman or the amateur ornithologist than are the woodpeckers. In spite of the fact that they constitute a large family of over 375 species and are found over the entire world, except in Madagascar and the Australian region, they are remarkably uniform in their habits and in their modifications. Indeed, some of the distinct and even strikingly marked species, like our downy and hairy woodpeckers, resemble each other almost feather for feather. Twenty-four of the nearly 200 species of woodpeckers occurring in the New World are found in North America.

The typical woodpeckers have large heads with stout chisel-like bills which end in a narrow edge rather than a point, and are thus well suited for chipping wood. Their tongues are very long, capable of being protruded a couple of inches beyond the tip of the bill, and have recurved barbs at the tip. This combination of bill and tongue make a perfect tool for drilling into the chambers of wood-boring larvae and spearing the concealed grub. For this reason woodpeckers are considered one of the most valuable groups of birds.

A RED HEADED WOODPECKER RETURNING TO HIS APARTMENT

When he returned from the South a flicker had usurped his previous years' hole and he was compelled to drill another higher up. The two families had frequent quarrels.

The tail feathers of the woodpeckers are very stiff and pointed and serve as props to support the weight of the birds as they climb the trunks of the trees in their characteristic manner. The tiny woodpeckers of South America and Africa, called piculets, and the four species of wrynecks of the Old World, however, have soft tails.

The feet of woodpeckers, likewise, are adapted to this climbing habit and differ from all of the birds that we have thus far considered, in having two toes directed forward and two backward. Thus they serve as pincers for better grasping the bark. In a few species, the three-toed woodpeckers of northern North America, one hind toe has been lost.

Because of all these modifications, the woodpeckers are separated from the Order Passeres or "Perching Birds" to which the families heretofore considered belong, and are put in an order by themselves, the Pici.

In color, the woodpeckers vary from the common black and white varieties, through various shades of brown and green, to those that are brilliant scarlet and yellow. In fact, patches of scarlet are found on the heads of the males of most species, even the most dully colored.

Woodpeckers are usually solitary birds and even the family parties disperse soon after the young are able to care for themselves. Our northern species, however, sometimes gather in scattered groups during the winter, often accompanying the flocks of chickadees and nuthatches, and regularly come to feeding stations maintained for them. In fact, they become so fond of suet that they continue to visit pieces hung in the trees all through the summer months, even when they drip in the sun and become rancid. They even feed their young with some suet and bring them to it when they are able to fly.

In nesting habits also, woodpeckers are remarkably uniform, for they all drill holes in dead or soft-wooded trees and lay their eggs on the chips at the bottom of the cavity. The size of the hole varies from about one and a half inches in diameter with the downy to two and a half inches with the flicker, and is correspondingly larger with the pileated and ivory-billed species. The hole is directed toward the center of the tree but a short distance and then drops downward for from six to eight inches to two feet and is usually enlarged toward the bottom for the convenience of the incubating bird. Usually both birds assist in drilling the hole and often carry the chips to some distance from the tree in order not to attract attention to it. The eggs are always glossy white and unspotted, but the number varies with the different species from four to twelve. There is one celebrated case of a flicker which continued to lay as often as the eggs were removed, until it had laid 71 eggs in 73 days.

Most woodpeckers excavate new nesting cavities each year, but some return to the same hole year after year.