GEOLOGICAL SURVEY OF KENTUCKY.

TIMBER AND BOTANY.

B

COMPRISING SEVEN REPORTS ON THE FORESTS AND BOTANY OF DIFFERENT PARTS OF THE STATE.

STEREOTYPED FOR THE SURVEY
BY MAJOR, JOHNSTON & BARRETT.
YEOMAN PRESS, FRANKFORT, KENTUCKY.
1884.

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PREFACE TO SECOND EDITION (NEW SERIES).

It being necessary to publish a new edition of the Reports of the Geological Survey, it is thought proper to change the arrangement of the reports in the several volumes. This is advisable in order to bring together in one volume the several reports relating to a given subject or locality. In the first edition (second series) the volumes were made up of reports, regardless of subjects treated, and in order to learn all that may be published of a locality, the reader must examine several volumes. For instance, the reports on the iron ores and the iron manufacture of Greenup, Carter, Boyd, and Lawrence counties is in volume 1, and the Report on the Geology of the above named counties is in volume 2. The Chemical Reports and the reports on the Timbers are scattered through four volumes. This arrangement of reports could not have been avoided in the early history of the Survey without a delay in the publication of the volumes. It is thought that the arrangement in this edition will more fully meet the wants of the public, and will render the reports more valuable.

The first volumes of this edition will comprise the following: Chemical Analyses, Reports on the Eastern Coal Field; Reports on the Western Coal Field; Reports on Timbers. Other volumes will be published from time to time, preserving the same order of grouping reports. Some of the preliminary reports contained in the first edition have been omitted, in order that there may be no duplication when the final reports are published. I am of the opinion that enough preliminary or reconnoissance work has been done by the Survey, and the work will be directed with a view of securing (so far as the means will permit) complete reports on the geology, soils, timbers, etc., of the various regions

studied. As the stereotyped plates of the omitted preliminary reports are preserved, new editions may be ordered should there be a demand for them. A change has also been made in the size of the volume by decreasing the size of the margin, which, it is thought, will make the volume a more convenient size, both for library use and for sending through the mails.

JOHN R. PROCTER,
State Geologist.

GEOLOGICAL SURVEY OF KENTUCKY

N. S. SHALER, DIRECTOR.

REPORT ON THE FORESTS

OF

GREENUP, CARTER, BOYD & LAWRENCE COUNTIES.

BY N. S. SHALER AND A. R. CRANDALL.

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REPORT ON THE FOREST TIMBER

OF

GREENUP, CARTER, BOYD & LAWRENCE COUNTIES.

INTRODUCTION.

The questions, both scientific and economic, which are connected with our forests, are at once numerous and of very great value. The student finds himself led to the study of the laws determining the growth and succession of the trees; the way in which they are connected with the underlying rocks; the history of their creation or appearance in their present places, and many other similar matters. Some of this class of questions are purely scientific; that is to say, they do not connect themselves with any immediate monetary result. The plan of this Survey contemplates their study quite as much as if they were of pecuniary value; but these scientific results will find their place in the memoirs of the Survey which will be specially devoted to purely scientific matters, while the reports are to be given to the questions of economic value. It must not be supposed, however, that the separation of these two classes of treatises will be absolute; science is so far the handmaiden of the arts that it must always go with them if they are to retain their best value. The reader will, for instance, notice, that along with the common names of the trees in this report are given also the scientific names of the species. In no other way would it be possible to make it certain just what sort of tree was meant by the name; for the familiar name of a tree may vary from place to place, while the scientific name is the same for all countries, and enables us to designate the given kind of tree, so that all botanists can make sure of it. The way in which the timber is distributed, with reference to the underlying rock and the quality of the soil, are also

questions at once scientific and economic in their value. These are only a small part of the questions where the scientific and the practical values come together, but they serve in a small way to show the essential connection between the two.

Hitherto all the descriptions given of forest timber have been very indeterminate, as far as concerns the size and number of the different kinds of trees on given areas. In laying out a plan for the work of the Kentucky Survey, it seemed desirable to take an account of our forests in such a fashion that it would be possible to obtain precise statistics concerning every important feature capable of being accurately measured. It was obviously necessary to count the number of trees to the acre on several different exposures in each district, taking account of the different species, so as to show their relative proportions and average size. Mr. Crandall has been charged with the execution of this plan, and he has perfected it in several essential particulars. His method of indicating the distribution of the species of trees on different slopes of the same hill is entirely original, and expresses the facts in an admirable manner. It is in the plan of the Survey to carry this same system of delineation over the whole of the State, with a view to give a record of the present condition of our forests, in order that their changes in coming time may be determined, and especially that their economic value may be properly appreciated. I am satisfied that, by properly husbanding our timber resources, they will in fifty years become one of the most important of the varied sources of wealth to our State. A large part of the eastern coal-field of Kentucky is not tillable land. The lofty and rugged ridges between the valleys are natural nurseries of timber. While they will not serve for other forms of cultivation, they will yet do admirably for the raising of many of the most valuable woods for our various arts. So large a part of the Valley of the Ohio is arable land, that the future sources of timber for its use are very limited. They will be found in the lofty ridges of the Apalachian Mountains where the steepness of the slopes will forbid plow tillage.

I deem it quite likely that within the time of the next generation these hill lands will become as valuable for timber-raising as the average lands of the valley are for other forms of culture. They are naturally suited to all the most valuable woods of the Mississippi Valley. At the present value of black walnut, an acre of this timber forty years old, growing as thickly as it is able to stand, should be worth several hundred dollars; of hickory and locust of second growth the value is about as great. There are few crops of the ordinary soil which will give as great average returns when labor and interest are deducted. A very great advantage in our Kentucky forests is the comparative immunity from fires. In most valuable timber regions this danger is so great as to reduce the value of such lands as investments. In many thousand miles of travel through the timbered districts of Kentucky, I have never seen an acre of forest seriously damaged by fire. In the present state of our American life, when men are hardly willing to wait for the yearly harvests to mature, it seems almost too much to hope for the far-seeing thrift that will look forward to fruits to be gathered at the end of forty years; yet these enterprises that take hold on a distant future will become more attractive, with a growth of capital and an increase of confidence in life. But in fact a large part of the value of such growths as our forests would give when artificially planted would be immediate; at five years young hickories have a value; and the trees removed by trimming out each year, should pay an interest on investment. The black locust becomes valuable in ten years, or nearly as soon as a pear orchard, and for thirty years thereafter should give a steady supply of timber. With each succeeding year these woods become more and more valuable as the original forests become stripped of their scanty supply. The best black walnut is already priced with mahogany in Europe, bringing several dollars per cubic foot. The abundant water-ways of the Ohio Valley will always make its regions of permanent forests of peculiar value.

There is another and most important reason for retaining the forest covering of our eastern hills. The surface of that

country is so rugged that nearly seven eighths of its area lies in slopes of great steepness. If stripped of their timber, the water will not lie on these slopes much longer than on the house tops.

By the forest covering a large part of the water is retained as by a sponge, and is allowed to filter away slowly into the streams. A heavy rain of say five inches in depth, falling within say two days, will have at least one half of the precipitated water retained for some days in the mat of decaying leaves of the forest, which would otherwise be precipitated at once into the streams. To strip away the forests is to double the amount of water thrown at one stroke into the rivers. A glance at the map of the Big Sandy or Chatterawha Valley will show that this stream has a great many branches, and gathers the water from about five thousand square miles of mountainous country. Every part of this area is made up of narrow valleys and steep hillsides. As it is, the floods of the Lower Sandy rise to about fifty feet above the low-water stage of the river, and are formidable in their violence. If the country should ever become stripped of its timber, the consequences would be disastrous in the highest degree. Some of the valleys of a similar character in Europe, which have been recklessly stripped of their timber, have become almost devastated by the violence of the floods. There are several such cases in France where the soil has been in good part stripped away since the timber was removed, and the government has been compelled to intervene in order to restore the forests. When this restoration has been accomplished, an immediate change for the better has been brought about. Thus we see that there are two good reasons for endeavoring to retain the forests of the Big Sandy Valley. Firstly, that they may remain a source of supply for valuable timber, which each year must enhance in price on account of the increasing population of the Ohio and Mississippi Valleys; secondly, on account of the safety of the agricultural and mining interests of the region which must be located along the valleys, and thus be in great danger from any increase of the floods which now sweep them.

It may be urged in addition that the best interests of this valley demand that the streams, even to their second and third branching, should be used as a means of bringing out the mineral and timber stores. This will require the extensive use of locks and dams; and these structures, already difficult to construct on account of the violence of the floods, would become quite impossible if their force is increased, as it will be by the destruction of the forests. The mineral region of Eastern Kentucky has a precious heritage in its forests, ores, and coals. All the skill of legislation, and all the discretion of private enterprise, should be directed to securing the best products from these resources, avoiding destructive waste. This cannot be done except by preserving the forests without great reduction from their present area. If the State, or the counties thereof, still own large tracts of forest timber, it would be clearly in the line of true policy to retain those areas as public domains in the interest of coming generations. Throughout Switzerland and other parts of Europe the communal forests, rarely large in area, are the most precious of the public domains. From them the citizens derive in many cases sums so large as to form a considerable element in their private revenues. Every county in our mountain districts that will put aside as public land ten thousand acres of forest, worth to-day as many dollars, will, at the end of a century, have a princely domain. There is, in a word, no gift that the present generation can make to the future so precious and so noble as untouched areas of our magnificent forests. For us it requires little forbearance to spare what will be to them a most precious heritage.

N. S. SHALER.

INTRODUCTORY LETTER.

Professor N. S. SHALER,

Director of the Kentucky Geological Survey:

The accompanying brief report on the Timber of Eastern Kentucky is made up from observations made during the progress of the geological work in the field which it includes. The work on which it is founded is, therefore, secondary, and somewhat unsatisfactory in details. It may serve, however, as an introduction to a study of the forest growth of this section.

A. R. CRANDALL,
Assistant Ky. Geological Survey.

REPORT ON THE TIMBER GROWTH

OF

GREENUP, CARTER, BOYD & LAWRENCE COUNTIES,

IN EASTERN KENTUCKY.

By A. R. CRANDALL.

The timber of Eastern Kentucky might, from its suitableness to meet two classes of wants, be considered with reference to use in iron-making, or as fuel; and with reference to the uses which give rise to a demand for lumber and other forest products. Following this division of the subject, a very large proportion of the forest growth would fall under the latter heading. But as practically the purpose to which it will be turned depends not so much on the character of the timber itself as on the character of the demand for it—a demand shaped largely by such accidents as the facilities, or want of facilities for transportation—it will be as well, perhaps, to treat the subject in a more general way, or simply as to the kinds of forest trees and their distribution.

The difficulties which now stand in the way of bringing the more valuable timber of Eastern Kentucky into market, inevitably turn it to furnace use where furnaces are within reach; and where neither furnaces nor marketing facilities give immediate value to the forests, the timber that is not burned in the ordinary process of clearing and fencing land, or that is not wantonly destroyed, awaits the developments of time only to determine whether the more valuable part shall be turned to use in a wide range of wood manufactures, or consumed indiscriminately with the rest in the smelting of the ores which abound in this region.

The subject may be conveniently divided, however, so as to present it with reference to a number of questions which naturally arise with the study of the forest growth. After the occurrence of species, the number and size of the various trees, of scarcely less importance is their geographical distribution; the effect of varying surface conditions, as found in a hilly country, and also the effect of varying exposure. Not altogether foreign to an economic view of the subject is the question of geological distribution, or the assemblages of species on particular geological formations. It is possible that generalizations may be reached by which the forest growth will give an important clue to geological formations. A sufficient number of observations have not yet been made to warrant such generalizations for this field. But it is important that the facts should be so recorded as to facilitate a careful study in this direction, when additional data shall have been gathered from a wider range of country. This branch of the subject will, therefore, be left for future treatment.

No complete list of the kinds of trees found in this section can yet be given, as, indeed, only a beginning has been made in so considerable a task as is involved in even a preliminary study of the forest trees of so extended and so varied a field. Still enough has been done to foreshadow good results, both economic and scientific.

In the presentation here made, it is taken for granted that the value of the different kinds of wood for the various purposes to which they are suited, is too well known to require special mention. For the present also the question of facilities for transportation and marketing will be left to the enterprising, in the hope that a simple statement of facts will serve equally well to encourage practical solutions of the question to the advantage of all parties interested.

The accompanying tables show approximately the relative abundance of the more common species of trees. These tables are made up from studies made partly by Mr. J. A. Monroe and partly by myself. The timber on an acre (estimated or paced) is included in each observation; and when

practicable, observations were made so as to give an account of the number of trees representing each species. First, in the bed of the valley, including also, in most cases, about an equal area of slope; second, the side hill at that part of the slope which appeared on all accounts to be most nearly a medium between hill-top and valley; and third, the top of the hill or ridge, including more or less slope. The tables are so arranged as to give the relative abundance of different species for a number of localities at these levels. The per cent. of each species in a given locality, the per cent. of each species at the several levels for all localities included, and the per cent. of each species in the whole timber growth of the country, are also given; the counts chosen being regarded as representative for this part of Eastern Kentucky. It should be remarked here that in some instances an unusual growth of certain species, from some cause to which it is important to call attention, has been included; but with such qualifications as are made in the general mention of species, the tables will be found reasonably correct.

TABLE I.—Old Forest Growth.

SPECIES.	*Near head of Irish Creek, Lawrence County.*				*Blain, 1 mile above mouth of Cherokee Creek, Lawrence Co'ty.*				*Little Fork of Little Sandy, Graham Hill, Carter Co'ty.*				*Various localities in Carter, Lawr'ce, and Boyd.*				*Slash Branch Laurel Furnace Land, Greenup Co.*			
	Valley (horizon of C. No. 2)	Hillside (horizon of No. 3 C.), 100 to 150, S. W. ex.	Top of hill (horizon of C. No. 7), 250 to 300	Per cent. for locality	Valley (horizon of No. 1 C.), east side	Hillside (above C. No. 3), S. E. exposure	Top of hill (horizon of C. No. 7), 300 to 350	Per cent. for locality	Valley (horizon of main block ore)	Hillside (horizon of L. ore), 150 to 200	Ridge (horizon of C. No. 8), 300 to 350 above drainage	Per cent. for locality	Laurel Fork of Blain (Cong. S. S.), valley	Head of Lost Fork (Mahoning S. S.), 200, W. exposure	Divide between Chadwick's and White's creeks, 350	Per cent. for locality	Valley (horizon of Waverly S. S. and S.)	Hillside (horizon of Cong. S. S. and Sub-carb. L.), E. ex.	Hill (above Cong. S. S.)	Per cent. for locality
White oak	14	20	25	.224	6	25	2	.140	13	35	.	.157	14	3	13	.140	12	17	8	.177
Black oak	.	25	10	.133	.	3	10	.055	5	11	20	.118	.	4	12	.075	3	6	10	.091
Chestnut oak	.	.	25	.080	.	9	48	.243	.	5	72	.252	.	4	30	.159	.	4	17	.100
Post oak	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Other oaks	.	.	6	.023	.	2	1	.013	.	1	.	.003	.	5	.	.023	.	3	.	.014
Beech	25	.	.	.095	51	3	.	.229	37	10	.	.154	16	.	.	.075	14	11	.	.120
Maple	10	.	.	.038	4	5	3	.051	26	2	.	.092	25	3	.	.131	4	3	.	.033
Chestnut	.	.	.	.	.	6	.	.026	4	.	.	.013	.	4	6	.045	4	.	12	.077
Hickory	.	25	15	.152	.	12	21	.140	7	16	4	.095	.	5	4	.042	10	8	3	.100
Yellow poplar	.	.	.	.	3	4	.	.030	6	3	.	.029	.	6	.	.028	7	4	8	.091
Gum	3	.	.	.011	.	8	.	.034	3	6	.	.029	4	5	2	.057	2	2	3	.033
Ash	.	.	.	.	.	2	.	.009	1	2	.	.010	4	3	.	.033	.	1	.	.
Linden	.	.	.	.	.	.	.	.	1	.	.	.003	4	8	.	.056	4	.	.	.019
Sycamore	5	.	.	.019	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.043
Buckeye	.	.	.	.	2	.	.	.009	.	.	.	.	.	.	.	.	3	.	.	.014
Elm	.	.	.	.	.	.	1	.004	.	.	.	.	2	2	.	.019	3	.	.	.014
Black walnut	.	.	.	.	2	.	2	.017	1	.	.	.003	.	4	.	.019	2	.	.	.010
White walnut	.	.	.	.	.	.	.	.	.	.	1	.003	.	.	.	.	.	.	.	.
Hemlock	18	.	.	.068	.	.	.	.	.	.	.	.	15	.	.	.070	.	6	.	.029
Pine	.	31	10	.156	.	.	.	.	.	.	13	.043	.	.	7	.035	.	.	6	.029

TABLE I.—Old Forest Growth—Continued.

SPECIES.	*Raccoon Furnace Lands, Greenup Co.*				*East Fk., near Cannonsburg, Land of V. Calvin, Boyd County.*				*Ellington s, Bear Creek, Boyd County.*				Per cent for all localities—valley	Per cent. for all localities—hillside	Per cent. for all localities—top of hill	Per cent. for all localities
	Valley (horizon of No. 1. C.)	Hillside (between C.'s No. 2 and No. 3, 200)	Top of hill (horizon of C. No. 3), 300 feet above drainage	Per cent. for locality	Valley (horizon of No. 6 C.)	Hillside (horizon of No. 8 C.), 100 to 150 S. E. ex.	Top of hill (horizon Mahoning S. S.), 300	Per cent. for locality	Valley (horizon of No. 8 C.)	Hillside (horizon of Mahoning S. S.), 150 to 250	Top of hill (above Mahoning S. S.), 300 to 350	Per cent. for locality				
White oak	14	17	13	.187	17	19	12	.195	15	19	12	.152	.149	.237	.129	.171
Black oak	12	11	17	.170	12	10	9	.126	11	14	20	.149	.061	.129	.164	.117
Chestnut oak	.	.	.		1	7	8	.065	.	.	.	. .	. .	.044	.297	.112
Post oak	.	.	.	. .	.	3	4	.028	.	.	8	.026	. .	. .	.018	.007
Other oaks	.	8	14	.090	8	7	5	.081	4	4	10	.060	.017	.046	.055	.038
Beech	9	12	2	.089	23	.	.	.093	21	9	.	.100	.278	.069	. .	.119
Maple	3	3	.	.026	6	9	.	.061	4	5	.	.030	.116	.046	.005	.057
Chestnut	.	4	9	.055	2	3	2	.028	4	4	6	.046	.020	.032	.053	.035
Hickory	4	4	9	.072	.	.	.	. .	.	9	10	.063	.030	.120	.100	.082
Yellow poplar	13	.	4	.072	4	7	6	.069	12	14	5	.102	.064	.058	.035	.052
Gum	.	3	8	.047	6	3	.	.037	4	3	4	.036	.031	.046	.026	.034
Ash	.	.	.	. .	.	.	.	. .	.	4	4	.026	.007	.018	.006	.010
Linden	3	2	.	.021	.	.	.	. .	6	.	.	.020	.026	.015	. .	.014
Sycamore	8	.	.	.034	13	.	.	.053	9	.	.	.030	.062	. .	. .	.022
Buckeye	7	.	.	.030	.	.	.	. .	3	.	.	.010	.021	. .	. .	.007
Elm	3	4	.	.030	14	8	.	.089	4	.	.	.013	.037	.021	. .	.020
Black walnut	3	6	.	.038	3	.	.	.012	7	5	.	.040	.026	.023	.003	.017
White walnut	.	.	.	.	2	.	.	.008	3	.	.	.010	.007	. .	.002	.003
Hemlock	.	.	.	. .	.	.	.	. .	.	.	.	. .	.047	.009	. .	.019
Pine	.	.	8	.034	.	4	9	.053		9	17	.086	. .	.067	.106	.056

Table I is made up from counts of old forest trees. Table II of second growth.

It will be noticed that the white oak (*Quercus alba, L.*) has a wider range and a greater development in numbers than any other species. In size, it ranks with the largest of the hard wood trees, often reaching a diameter of three and a half feet. It is probable that, along with its adaptation to a wide range of surface conditions in its growth, there is some variation in the quality of the wood; but it occurs in nearly all valleys, and well up on the slope of most hills, in such size, and apparently of such quality, as is usually sought after for the purpose for which it is most valued. In many instances of growth on a southern or southwestern exposure, it is comparatively small in size. The same may be said of the tops of many hills; but the average size and height is such as to warrant a very liberal estimate, wherever the forest remains, for that alone which is available for lumber. In point of number the white oak makes up about seventeen per cent. of the forest growth. Its large average size gives it still greater prominence.

The black oak or yellow bark oak (*Quercus tinctoria, Bertram.*) has a range not unlike the preceding. It also constitutes a large per cent. of the forest growth. A considerable number of smallish trees, which doubtless represent to some extent a second growth, are included in most of the observations of Table I, giving undue prominence to this species. It will be noticed that, in the table of second growths, it is still more prominent, showing an adaptation to a wide range of surface conditions. It would seem from these observations that the black oak is less fitted by the strength and durability of its wood to attain great age than is the white oak, though instances are not wanting in which it reaches a size equally as large.

The chestnut oak (*Q. castanea?*) often predominates on the ridges, extending its range downward in a rapidly decreasing proportion, rarely being found in the valleys. In this section, while it frequently attains a large size, it is generally inferior in height to the white or black oak. This is doubtless owing

partly to exposure to sweeping winds, and partly to the rocky character of the ridges on which it abounds. Further back in the country, and especially as noted on Laurel Mountain, where it is abundant over the greater part of the slope, the chestnut oak is not inferior in height to any of the oaks. While this is suggestive as to the cause of the disparity in height noted in the field covered by this report, it also gives rise to questions relating to its distribution, questions which may, however, with the suggestion, be left for further investigation.

The post oak (*Q. obtusiloba, Michx.*), a tree of medium size, is less abundant. It is found in various exposures in scattered growth. Its wood is very close, hard, and durable.

The other oaks noted, but which, for want of accurate distinction in some of the counts, are thrown together in the tables, are the red oak (*Q. rubra, L.*), which is abundant in many places. It reaches dimensions scarcely less imposing than those of the white and black oak.

The Spanish oak (*Q. falcata, Michx.*), which occurs mostly as second growth, but also as large trees, especially in Lawrence county.

The laurel oak (*Q. imbrecaria, Michx.*) also occurs in small size at a number of points in each county. Along Blain, and especially for some distance above the Falls, trees of large size are found.

The black jack or barren oak (*Q. nigra, L.*) occurs in various exposures, but mostly on the more barren and rocky slopes.

The oaks constitute about forty-two per cent. of the forest trees.

The beech (*Fagus ferruginea, Ait.*) ranks with the chestnut oak in abundance; but in distribution it is quite unlike that tree, being found mostly along the foot of the hills. It sometimes becomes prominent well up the slope, and not unfrequently occurs in scattered growth along the highest ridges. It often shows a diameter of three feet, and is on many accounts one of the most interesting trees in this section.

The maple is also abundant in some valleys, having a range not unlike the beech. The sugar tree or rock maple (*Acer*

saccharinum, Wang.) makes up a very large proportion of the maples. Along the banks of streams the white maple (*Acer dasycarpum, Ehrhart*) is common, while an occasional red maple (*A. rubrum, L.*) is found, as also the ash-leaved maple (*Negundo aceroides, Mœnch*). The latter tree affords a wood that is perhaps better suited for making small patterns or models than any other of our native trees. The numerical proportion of the maple, as of all those trees which have their greatest development along river and creek bottoms, has been greatly reduced by the clearing of land. Good sugar orchards have to be sought for the most part in unsettled localities.

The chestnut (*Castanea vesca, L.*) is found in all localities, and in such size as to give it a prominence much greater than is shown by its per centage in the tabular view. In the table of second growths an increased proportion is shown. The dwarf chestnut or chinquapin (*C. pumila, Michx.*) has not been noticed in this section.

The hickories are represented by many large trees. Table I, however, includes a considerable number of smallish trees, giving, perhaps, undue prominence to the hickories; but this fact is largely offset by the great number of small hickories, which are a common feature of the undergrowth, and which afford a large supply of hoop-poles.

The yellow poplar, the tulip tree or whitewood (*Liriodendron tulipifera, L.*), occurs in all localities. It ranks in size above all the other trees of Eastern Kentucky, unless the sycamore be excepted, which occasionally reaches immense size. The tulip tree ranges in size from two to five feet in diameter, having a cylindrical trunk of great length. The young tree is highly ornamental, both in form and foliage. Few small trees of this species are included in Table I, yet in number of individuals it makes up about five per cent. of the forest growth.

The gum tree or black gum (*Nyssa multiflora, Wang.*) grows in all localities, and is represented here and there by a tree at all levels in nearly all exposures. Its value as a suitable wood for wheel-hubs, and for other purposes for which a cross-fibred

wood is desirable, will doubtless give rise to a demand for this now somewhat despised tree.

The ash (mostly *Fraxinus Americana, L.*, or the white ash, but including two or three other species of rarer occurrence) is represented by some trees of large size, but by more of a smallish size, which may be regarded as a second growth in the old forest.

The linden or basswood is abundant in some shaded valleys and on some moist slopes. In the tables it falls below its proportional number, as do some other species, from the difficulty of selecting average localities for all the species.

The sycamore (*Platanus occidentalis, L.*) occurs along the river and creek bottoms as a large tree of irregular growth, sometimes reaching a diameter of six or seven feet. In second growth timber it is sometimes found along the slopes of hills, and even on the tops of ridges, as along the ridge road from Ashland to Clinton Furnace, 350 feet above drainage.

The buckeye (*Æsculus flava, Ait.*) occurs as a large tree low down in the valleys. In second growth it occurs higher up the hillsides, but somewhat rarely.

The elm is represented by several species—the *Ulmus Americana, L.*, or the American elm; *U. fulva, Michx.*, slippery elm, and *U. alata, Michx.*, winged elm. The first named being the common species. The others occur here and there as trees of moderate or small size.

The walnut trees (*Juglans nigra, L.*), black walnut and (*J. cinerea, L.*) white walnut or butternut, have about the same range, the former being most abundant. The value of this wood seems to be little understood in this section, as it is often used for fencing, or wantonly destroyed. It does not occur in great numbers in any particular locality, but is found along the hillsides and in the valleys of the smaller streams scattered among the other trees. Occasionally trees of great size are met with, as notably on Rock-house Branch of Jourdan's Fork, in Lawrence county. In the second growth the walnuts both show an increased per centage. It would certainly prove a wise policy to encourage the growth of both; but particularly of the

black walnut, the demand for which is rapidly outrunning the supply.

The hemlock or hemlock spruce (*Abies Canadensis, Michx.*) is restricted in its range to shaded ravines and rock-bound creeks. Cliffs and ledges of coarse sandstone, and particularly of the conglomerate sandstone, when near the bed of the creek, are often covered or surrounded by an almost exclusive growth of hemlock and laurel—trees and shrubs which make slight competition for the more open soil. The hemlock is not limited to coarse sandstone formations, however. It is found, less frequently, clinging to or growing along ledges of limestone, as on Tygert's creek, where it is associated with cedar, and also covering the steep faces of the Waverly sandstone, as exposed along some of the streams west of Tygert's creek.

The pines are represented by several species; the yellow pine (*Pinus mitis, Michx.*) being the common species. The white pine (*P. strobus, L.*) occurs on Buffalo creek, in Carter county. It is represented here by a few scattered individuals only. The scrub pine (*P. inops., Ait.*) is more common in second growth, as on the hills around Louisa.

The red cedar (*Juniperus Virginica, L.*) grows in many localities low down in valleys or on bluff-like hills; but it has a much more marked development along the outcrop of the subcarboniferous limestone than elsewhere.

Besides the trees mentioned in the tables, there are others of less common occurrence, as also a number of small trees and of shrubs, which, though they do not largely affect the character of the old forest, are worthy of mention.

The poplar (*Populus grandidentata, Michx.*) occurs at several points on low ground.

The persimmon or date-plum (*Diospyrus Virginiana, L.*) is found in nearly all localities. Attention has been called to this tree by a number of writers as one likely to repay with valuable fruit an intelligent effort to cultivate and improve it.

The cherry is represented by two species (*Prunus serotina, Ehrhart* and *P. Pennsylvanica, L.*), the former occasionally

growing to good size, as instanced by the beautiful tree in front of Mr. Scott's house, at Olive Hill.

The common locust (*Robina pseudacacia, L.*) occurs without apparent regard to level or exposure.

The honey locust (*Gleditschia triacanehos, L.*) is limited to the lower grounds.

The cucumber tree (*Magnolia accuminata, L.*) is found rarely in Carter and Lawrence counties. It is a large tree, and equally as valuable for lumber as the tulip tree.

The umbrella tree (*Magnolia umbrella, Lam.*) occurs in great numbers on the waters of the Chatterawha or Big Sandy, also on some of the tributaries of the Little Sandy. It is a small but interesting tree, and one that is very desirable for purposes of shade and of ornamentation. In Eastern Kentucky it grows mostly along the streams. In Tennessee I have noticed it covering a hill to the exclusion of other trees. It is likely, therefore, that no difficulty would be experienced in transplanting it to higher land and dryer soil.

The water birch (*Betula nigra, L.*) is abundant on the banks of some of the larger streams, like Tygert's creek, the Little Sandy, and Blain.

The black birch (*Betula lenta, L.*) was noted as a small tree at a number of points.

The hackberry (*Celtis occidentalis, L.*) has an occasional representation of moderate size.

The sweet gum (*Liquidamber styraciflua, L.*) was noted at a number of points along the border of Greenup and Lewis counties as an occasional tree of small growth. It has a considerable development, both in number and size, on Lick creek, near Louisa, in Lawrence county.

The mulberry (*Morus rubra, L.*) is found at wide intervals in the valleys and on the hillsides. A spreading tree, often of considerable size, and always bearing an abundance of rich fruit in its season.

The willows frequently border the streams with various growths, from the shrub to the large tree.

The catalpa (*C. bignonoides, Walt.*) is found both on cultivated and on wild lands. Whether native in the latter instance is uncertain from observations in this field.

The hop hornbeam or lever wood (*Ostrya Virginica, Willd.*) occurs only rarely and in small size.

Water beech (*Carpinus Americana, Michx.*) is abundant everywhere, sometimes reaching eight to ten inches in diameter. It is a very close-grained wood, and may be made valuable for turning by boiling or saturating with water before drying.

The dogwood (*Corus florida, L.*) is also abundant throughout. It rarely reaches a diameter of ten inches, but it grows a more regular and shaft-like trunk than the preceding, while it is equally close-fibred, and more readily seasoned for use.

The Juneberry or service berry (*Amelanchier Canadensis, Torr & Gray*) has an occasional representative.

Sassafras (*S. officinale, Nees.*) is common, and usually associated with the sour tree or sorrel tree (*Oxydendrum arboreum, D. C.*)

The pawpaw grows in dense thickets along the foot of most hills, extending up ravines and reaching up hillsides in lessening numbers. It is sometimes found near the tops of hills 250 to 300 feet above drainage.

American holly (*Ilex opaca, Ait.*) is usually found associated with hemlock and the laurels in rocky and broken areas.

The redbud (*Circis Canadensis, L.*), the black haw (*Viburnum prunifolium, L.*), spicewood (*Benzoin oderiferum, Nees.*), hazelnut (*Corylus Americana, Walt.*), and the witch hazel (*Hamamelis Virginica, L.*) are occasionally met with.

Sumach (*Rhus copalina, L.*), alder (*Alnus serrulata, Ait.*), and several species of thorns, are more common. The hawthorn occurs near Ashland, probably introduced. Leatherwood (*Dirca palustris, L.*) has been noted at several points west of Tygert's creek. The crab apple and the wild plum sometimes make up a part of thickets, which appear to be a wild growth.

Grapevines, the climbing bittersweet, the Virginia creeper, as well as the poison ivy, frequently overrun the smaller trees

and shrubs, or cling to the larger trees. Other climbing vines and many small shrubs might be added, but may well be reserved for a more extended catalogue of plant species.

SECOND GROWTH.

The character of the timber growth, which springs up where old forests have been removed, has been made the subject of some investigation—the furnace lands affording an opportunity for comparing the second and also the third growth with that of the original forest. There seems to be very little difference between the second growth and the third as to the species represented, or as regards the numerical proportion of the species. It is deemed sufficient for the present purpose to present a tabular view of such observations as appear to be representative of the second growth in this section. Table II affords an easy means of comparison with the original growth of timber.

It will be noticed at once that the assemblage of species is very similar to that of the old forest. A little closer comparison will show that the changes indicated are such as to add to, rather than detract from, the value of the second growth. This is equally true, whether regarded as fuel for the furnace or as growing timber for future market.

Those trees, which grow chiefly on bottom lands and near creeks, show a falling off in number for the reason that the lands at this level are so generally under cultivation as to limit observations to the slopes and the tops of hills.

It is well known that in many localities the character of the second growth is quite unlike that of the original forest; and often the new growth is made up of species so inferior for fuel, or any of the purposes for which wood is in demand, that it is of little economic value. An interesting and important field for investigation is opened here; but for the present it will suffice to call attention to the importance of the fact where the second natural growth and the succeeding ones are not inferior to the old forest growth. This is readily seen from an illustration furnished by the locality in question. Notwithstanding

the abundance of mineral coal, the value of charcoal iron is such as to warrant the building of charcoal furnaces where both timber and ores are abundant; and as the consumption of timber in iron-making rapidly sweeps away the old forest, it is of no small importance that nature instantly sets about replacing in kind what is consumed from year to year by the furnace.

The statistics of Mt. Savage Furnace, which may be taken as a representative instance, show a consumption of about twelve thousand cords of wood per year, or for an average blast of a little more than three thousand tons iron product.

Allowing thirty to thirty-five cords of wood to the acre—a low estimate for hill and valley—gives a yearly decrease in forest area of from three hundred and fifty to four hundred acres. From the best information obtained in this furnace region, it appears that from twenty-three to twenty-five years' growth is required to give an average of thirty to thirty-five cords of wood per acre. From this it appears that a tract of nine to ten thousand acres is sufficient for the establishment of a perpetual charcoal furnace of ordinary capacity.

TABLE II.—Second Growth.

SPECIES.	*Hunnewell Fur. Lands, 23 years' growth.*			*Star Fur. Lands, 24 years' growth.*			*Buena Vista Furnace Lands, 22 years' growth.*			*Buena Vista Furnace Lands, Boyd County.*		
	Hillside (horizon of No. 3 C.), 100 to 150	Top of hill (horizon of L. ore), 200 to 250	Per cent. for locality	Hillside (horizon of C. No. 7), 100 to 150 above drainage	Top of hill (horizon of No. 8 C.), and above 250	Per cent. for locality	Hillside (horizon of L. ore), 75 to 150	Top of hill (horizon of No. 8 C.), 150 to 250	Per cent. for locality	Hillside (horizon of No. 7 C.), 100 to 200	Top of hill (horizon of No. 8 C.), 250 to 300	Per cent. for locality
White oak	30	34	.194	40	46	.248	38	36	.214	20	34	.172
Black oak	36	40	.237	18	34	.150	28	26	.150	32	20	.165
Chestnut oak	2	4	.019	8	8	.046	12	20	.092	6	. .	.019
Post oak	2	. .	.006	. .	. .	. . .	2	. .	.006	. .	. .	. . .
Other oaks	42	34	.237	30	24	.127	20	26	.133	16	26	.134
Beech	. .	4	.012	12	. .	.035	12	. .	.035	8	. .	.025
Maple	2	. .	.006	. .	. .	. . .	. .	. .	. . .	6	. .	.019
Chestnut	4	. .	.012	26	16	.121	14	. .	.040	12	10	.070
Hickory	10	4	.043	16	18	.098	18	30	.139	20	26	.140
Yellow poplar	9	8	.053	18	8	.075	8	8	.046	6	. .	.019
Gum	. .	6	.019	. .	6	.017	. .	. .	. . .	. .	. .	. . .
Ash	5	4	.028	6	6	.035	. .	. .	. . .	.	4	.013
Linden	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Sycamore	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Buckeye	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Elm	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Black walnut	12	8	.062	. .	. .	. . .	6	18	.069	20	10	.095
White walnut	4	6	.031	. .	. .	. . .	. .	. .	. . .	21	. .	.067
Hemlock	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Pine	. .	11	.034	. .	16	.046	2	24	.069	8	9	.054

TABLE II.—Second Growth—Continued.

SPECIES.	*Clinton Furnace Lands, Boyd C'ty.*			*N'r Grayson, Carter County.*			*Buffalo Furnace, near head of Oldtown Cr'k, North Fork.*			Per cent. for all localities—side of hill	Per cent. for all localities—top of hill	Per cent. for all localities
	Hillside (horizon of L. ore and C. No. 7), 50 to 100	Top of hill (horizon of No. 8 C.), 150 to 200	Per cent. for locality	Hillside (horizon of No. 2 C.), 100 to 150	Top of hill (horizon of No. 3 C.), about 200	Per cent. for locality	Hillside (horizon of No. 2 C.), 100 to 150 above drainage	Divide (horizon of No. 3 Coal), 250 above drainage	Per cent. for locality			
White oak	32	36	.223	32	22	.160	30	33	.187	.191	.210	.202
Black oak	38	30	.223	32	34	.200	35	36	.211	.189	.191	.190
Chestnut oak	16	4	.066	14	16	.089	. .	. .	. . .	.050	.045	.048
Post oak	12	2	.046	6	6	.036	. .	9	.027	.019	.015	.017
Other oaks	40	16	.184	12	24	.107	10	12	.164	.138	.141	.140
Beech	6	4	.033	22	8	.089	15	. .	.045	.065	.014	.039
Maple	. .	2	.007	16	26	.025	11	. .	.033	.030	.024	.027
Chestnut	8	14	.072	. .	12	.036	16	30	.137	.069	.071	.070
Hickory	. .	6	.020	16	16	.095	13	12	.074	.080	.098	.089
Yellow poplar	12	. .	.039	. .	. .	. . .	9	12	.062	.054	.031	.042
Gum	4	3	.023	8	3	.032	5	9	.042	.015	.024	.019
Ash	. .	. .	. . .	. .	. .	. . .	2	9	.033	.011	.024	.016
Linden	. .	.	. . .	. .	. .	. . .	. .	6	.018	. . .	. . .	.003
Sycamore	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. . .	. . .	. . .
Buckeye	. .	. .	. .	. .	. .	. . .	. .	. .	. . .	. . .	. . .	. . .
Elm	. .	. .	. . .	12	. .	.036	. .	. .	. . .	.010	. . .	.005
Black walnut	12	4	.052	. .	. .	. . .	7	9	.048	.049	.043	.046
White walnut	. .	. .	. . .	. .	. .	. . .	. .	6	.018	.022	.010	.016
Hemlock	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. . .	. . .	. . .
Pine	. .	4	.013	. .	. .	. . .	. .	. .	. .	.007	.056	.031

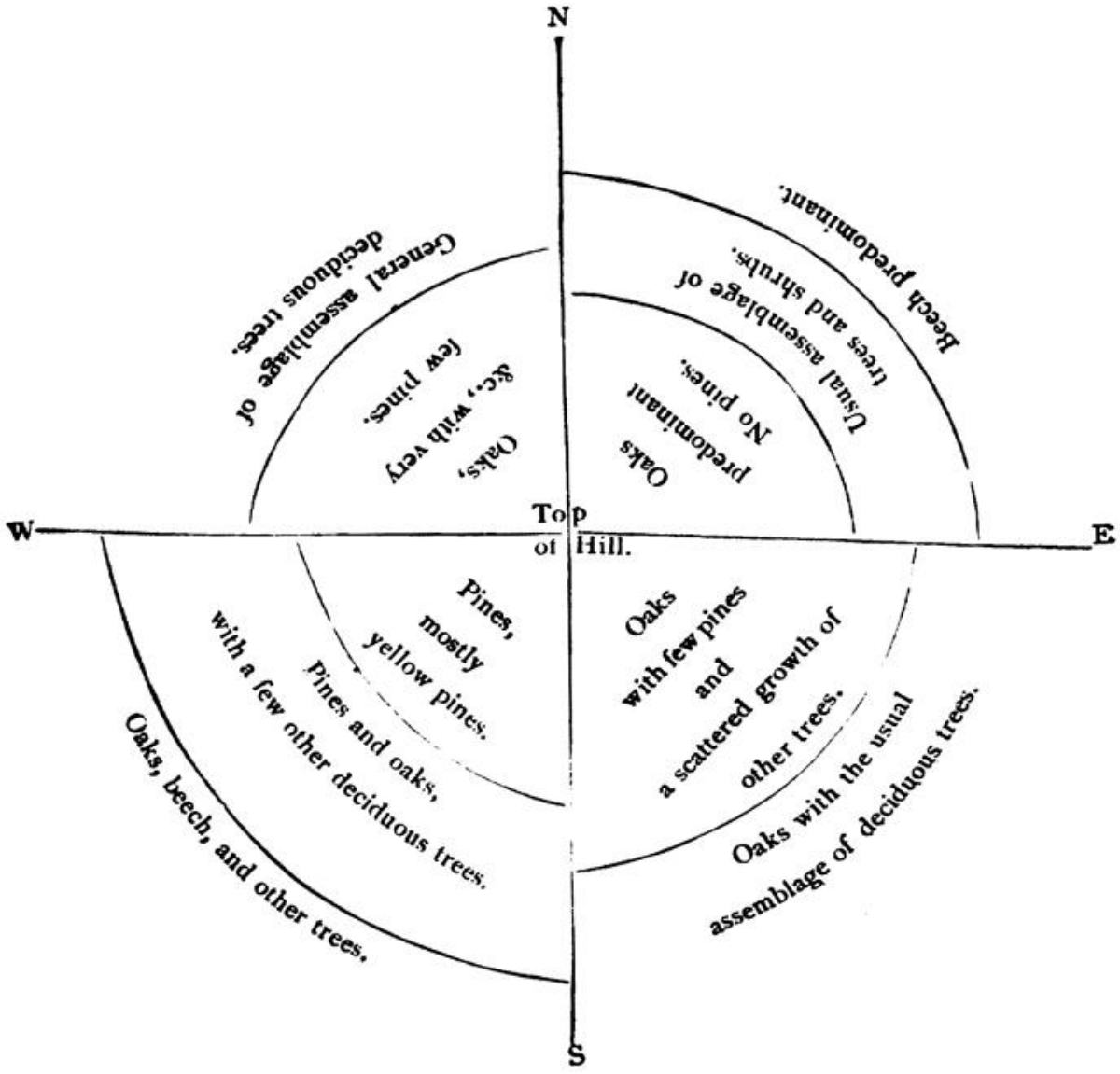
DISTRIBUTION OF SPECIES AS AFFECTED BY TOPOGRAPHICAL FEATURES.

In the first tabular view the effects of these conditions which arise from the hilly character of Eastern Kentucky may be traced in considerable detail. A careful study of this table will place many of the facts which belong to this phase of the subject at the disposal of the reader, and any general conclusions touching the question may well be reserved for such modification as may follow from more extended observation.

The effect of varying exposure is less satisfactorily shown than that of varying height from drainage. Generally the direction of slope is given; but a sufficient number of observations have not been included to make the presentation represent the facts for more than a small part of the almost numberless variations in exposure, which result from the irregularities of the drainage. Some very good illustrations of the effect of exposure, as regards direction, are found in the hills formed by the Waverly sandstone, which are sometimes knoblike, and, therefore, present a good example of varying exposure in a small field.

The diagram on the following page, which is made up from observations on some of the knoblike hills on Triplet creek, in Rowan county, will serve to call attention to some of the facts which belong to this branch of the subject. Special investigation in this direction would develop many interesting facts.

The steepness of the surface, as well as the direction of exposure, has much to do with the distribution of species; and as the peculiarities of hill profiles may often be referred to the character of the rocks out of which the hills are carved, as it were, by the agencies of erosion, the effects of varying exposure are more or less intimately associated and blended with those effects which properly belong to the question of geological distribution. A discussion of the relation of the two phases of the subject may, therefore, be left for a fuller presentation of the whole question.


N
W
E
S
Top of Hill.
Beech predominant.
Usual assemblage of trees and shrubs.
Oaks predominant
No pines.
Oaks, &c., with very few pines.
General assemblage of deciduous trees.
Oaks with the usual assemblage of deciduous trees.
Oaks with few pines and a scattered growth of other trees.
Pines, mostly yellow pines.
Pines and oaks, with a few other deciduous trees.
Oaks, beech, and other trees.