Forest Cover Photo-Interpretation Key for the Piedmont Forest Habitat Region in Alabama

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Forest Cover Photo-Interpretation Key for the Piedmont Physiographic Province in Alabama

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INTRODUCTION

RELATIVELY FEW FOREST cover type photo-interpretation keys have been developed for civilian use anywhere and, as far as can be determined from an extensive search of the literature, only two (Parker and Johnson, 1969; and Northrop and Johnson, 1970) have been developed for conditions in Alabama. Furthermore, these two keys are applicable only to very small areas and both require special photography. In order to fill this gap and make aerial photographs more generally valuable to forest land managers, the Department of Forestry at Auburn University Agricultural Experiment Station has embarked on a program to construct a key for each of a set of forest habitat regions into which the State will be divided. This is the first of these keys.

The keys represent a departure from current practice in that they are designed for use by humans, not automatic data processing devices, and that they are based primarily on ecological relationships rather than spectral signatures. This general design was chosen deliberately because it was felt that the keys should be of use to *all* land managers in the regions covered, not only to those with access to special aerial photography and to the complex and expensive equipment needed when reflectance patterns are used as the basis for the interpretations. In addition, the keys are designed in such a manner that they can be used with either prints or transparencies and with photography taken under a wide range of film-filter-season-scale combinations. They should therefore be of value to most land managers in the areas covered.

Initially the objective was to prepare a key so that U.S. Department of Agriculture – Agricultural Stabilization and Conservation Service (USDA-ASCS) photographs[1] could be used to stratify forest cover into meaningful cover types. Consequently such photographs were used in the preparation of this key. However, the design of the key is such that it can be used with little or no modification with black and white infrared photography, either conventional or modified, and with minimal modification with normal color or color infrared photography. Photographic scales probably should be no larger than 1:10,000 because enough ground area must be visible in each stereopair that an accurate evaluation of the topographic position of each stand can be made. Large scales, especially when used in conjunction with small formats (e.g., 70 mm. photography), would be undesirable since the ground coverage for any one stereopair would be too small to reveal topographic relationships. It is probable that scales as small as 1:100,000 could be used if the base-height ratios were such that good stereo-images of the ground surface could be obtained.

The key has been designed to indicate the *probable species composition* of the stands being examined. It provides no information on the *condition* of the stands (i.e., the sizes of the trees making up the stands or their density). Stand conditions can be evaluated using a number of procedures which have been described elsewhere (Avery, 1968; Moessner, 1960; Spurr, 1960; Wilson *et al*, 1960). It must be kept in mind that aerial photographs record the situation as of a given point in time. The longer the time between film exposure and photo-interpretation, the greater the probability of errors in photo-interpretation. Forests are dynamic and change with time. Natural events such as plant succession, insect or disease attacks, and wind storms may change the species composition in a given area since the photographs were taken. Man-caused changes, such as logging, clearing, planting, and burning, may be even more extensive and profound. For example, the practice of introducing species into areas in which they are not native or planting species off their normal sites will completely invalidate a photo-interpretation key based on normal species occurrence-site relationships. For these reasons, one must not expect the key to yield accurate results when the photographs are old or where land use has tended to destroy the usual species occurrence-site relationships.

DESCRIPTION OF THE REGION

The location of the Piedmont Forest Habitat Region is shown in generalized form in Figure 1 and in detail on the county maps in Appendix III. For this key the conventionally accepted western boundary of the Piedmont physiographic province (Adams *et al*, 1926, and Johnston, 1930) was rejected in favor of one further east which excludes the Talladega Slate Zone from the area under consideration. This was done because the vegetation patterns in this mountainous area are sufficiently different from those in the rest of the Piedmont. It follows the pattern established by Hodgkins (1965) in his description of the forest habitat regions of the Southeast.

ECOLOGICAL FOUNDATION OF THE KEY

All persons concerned with plant ecology are aware of the correlations that exist between species occurrence and site

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[1] Since the early nineteen-thirties USDA-ASCS photographs have been made using panchromatic film in a camera equipped with an 8.25 inch focal length lens and a Wratten No. 12 (minus-blue) filter. The photographic scale has been 1:20,000 at approximately mean ground elevation and the format size has been 9 × 9 inches. In Alabama, the photographs have usually been taken in the fall, winter, or early spring. Recently, however, the agency, for reasons of economy, has modified the photographic specifications so that the scale is 1:40,000 and the focal length of the camera lens is 6 inches.

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characteristics. The site characteristics that can be used in a photo-interpretation key for forest cover types are essentially topographic in nature. Topography is important because it affects the plant moisture regime. On the photographs, upland sites can be distinguished from bottomland sites without much difficulty. In the uplands, the moisture regime is affected by position on the slope, degree of slope, and aspect, all of which can be evaluated on the photographs. Bottomlands can be classified by position within the drainage system and size of the associated stream and its attendant floodplain. Again, all these can be evaluated on the photographs.

Certain geologic factors also influence the moisture regime. Rocks that resist weathering usually are associated with poorer sites and rougher topography. Rocks that are less resistant to weathering are associated with better sites and gentler topography. This relationship was found to be of consequence in the Piedmont and is incorporated into the key through the recognition of monadnocks, formed from resistant rock, and "peneplane hills," derived from less resistant rock. These different types of hills can be distinguished on the photographs. Other important geologic relationships may not be evident on the photographs, as in the case of the three subdivisions of the Piedmont recognized in the key. These must be made available to the interpreter through the medium of maps.

Species distribution is not controlled solely by the amount of available water. Species become adapted to a certain set of conditions through evolutionary development. As a result, they occupy reasonably well defined geographic ranges. This also must be considered in a regional key of this type and can only be made available to the interpreter through the use of appropriate maps.

Plant communities tend to change with time, becoming more and more stable as far as species composition is concerned. This natural phenomenon is called plant succession. There is no single most stable species composition or climax community. The climax varies from site to site within a region. Successional stages are difficult to determine from aerial photographs. Little more can be done than to assume that the pine cover types represent earlier stages and the pine-hardwood and hardwood cover types represent later stages. These assumptions seem reasonable. Pines are light-seeded shade intolerant pioneer species that occupy areas soon after the forest cover has been removed. There are, of course, light-seeded intolerant hardwood species that may invade a denuded area along with the pines, creating a mixed forest cover. As time goes on, however, heavier seeded, more tolerant species become established under the pioneer species and the stand eventually becomes a pure hardwood stand made up of heavy seeded, tolerant species. Therefore, the percentage of dark crowns (pine) in a stand may be used as a rough measure of the stage of succession. Man's activities in the woods will not modify these general conclusions to any great extent. If a stand is clear-cut and the site is left in an appropriate condition, the new stand probably will be pine. If there is no site preparation, it is likely that, because of their sprouting capability, the new stand will be almost pure hardwoods. In any case, it is logical to expect an increasing percentage of heavy seeded, tolerant species as the percentage of dark-toned crowns in the stand canopy decreases. This is the only way the photo-interpreter can judge stage of succession.

The combination of topographic, geological, and broad species range information apparently can lead to reasonably reliable estimates of forest cover type occurrence when used in conjunction with tonal differences on the photographs.

DEVELOPMENT OF THE KEY

It was accepted initially that habitat-species occurrence relationships exist and that the problem was to determine which of these relationships could be used by a photo-interpreter attempting to determine the species composition of stands imaged on aerial photographs. Since little work had been done in the South on this problem, particularly on study areas as large and complex as the Alabama Piedmont, this project had to break new ground and much time and effort were expended on trial procedures before the final design of the key was crystallized. Because of this searching for profitable approaches it was impossible to use any formal statistical designs or analyses in the work leading up to the final key. The key is based entirely on evidence obtained during extensive field operations of a reconnaissance nature. Formal statistical testing procedures were not used in the development of the key.

Initially, transects were run across representative terrain in various parts of the Piedmont. These transects were arbitrarily laid out on aerial photographs in such a manner that they were reasonably accessible and appeared to include a wide variety of stands on different sites. For this work the term "stand" was defined as an area of forest land which appeared to have, on the photographs, a more or less homogeneous character with respect to species, tree sizes, and crown closure. Each transect was followed on the ground. The species composition and topographic situation were evaluated and recorded for each stand along each transect. The species composition initially was evaluated by observation alone but this was quickly abandoned in favor of point- sampling to obtain basal areas by species. The sampling points were arbitrarily selected so as to be in what were judged as typical parts of the stands. No attempts were made to use any form of formal probability sampling.

The data obtained from these transects fell into certain patterns which provided first approximations for the variables that eventually were incorporated into the key. The forest cover types defined in Appendix II are descriptions of species groupings that occurred repeatedly. These were tentatively described at an early stage, and the descriptions were crystallized after further field work provided a stronger base.

When the project was being planned, it was suggested that the Soil Conservation Service soil classes might be correlated with species occurrence. When attempts were made to relate these soil classes to stand data from the reconnaissance transects, the results were ambiguous and no usable relationships were found. Consequently, this approach to the problem was abandoned.

While the soil classification used by the SCS did not prove to be valuable, it soon became clear that slope position and aspect had powerful effects. It also was found that crest width and degree of slope influenced the distribution of species. Furthermore, it was found that conditions on the higher monadnocks were sufficiently different from those on ordinary peneplane hills to require recognition. As the reconnaissance transect phase of the study progressed it became evident that conditions in the three subsections of the Piedmont, the Ashland and Opelika plateaus and the Devil's Backbone (Figure 1), were sufficiently different and would have to be recognized in the key. It was at this stage that the decision was made to omit the Talladega Slate portion of the geologic Piedmont physiographic province, because conditions in this area were sufficiently different from the rest of the Piedmont.

After the preliminary relationships described above had been tentatively organized into a key, the field operations were modified to provide a basis for checking and improving the key. To do this a large proportion of the roads in the Region were systematically traveled and the forest cover alongside the roads was compared to the key, site by site. Most of this checking was done on back country and woods roads, passable only with a pickup truck or an all-terrain vehicle, in order to avoid the biasing effect of human activities near well-travelled roads. In addition to this vehicular reconnaissance, much work was done on foot. A number of hills, both monadnocks and peneplane hills, were explored in detail on foot to make sure that the slope position-aspect-species occurrence relationships indicated in the key were correct. In order to determine conditions along the major streams, such as the Tallapoosa and Little Tallapoosa Rivers, crews rafted down portions of the streams. These crews would stop at intervals and record conditions along transects run away from the river. The lake areas were reconnoitered by motorboat. Whenever the key was found lacking it was expanded or modified. This process was continued until it appeared that the key yielded correct results in all parts of the Region.

DESCRIPTION OF THE KEY

The final version of the key consists of two parts. The first is a typical dichotomous elimination key which leads either directly to a forest cover type or to a diagram of a hill. If one is referred to the hill diagram he should determine, from the photographs, the topographic position of the plot or stand in question and then he should locate that point on the diagram. The probable forest cover type occupying that position would then be read directly from the diagram. For example, if the first part of the key referred the interpreter to Figure 44A and the stand in question was on the lower slope of the northeast facing slope the forest cover type would be P(3).

FOREST COVER TYPES

The forest cover types recognized by the key are described in Appendix II. The descriptions are based on occurrence averages obtained from prism point samples obtained in the field operations previously described. Since the cover types are based on topographic position and percentage of dark toned crowns and not on the species groupings themselves, their stability with regard to species components is dependent on the number of species involved. Some of the cover types are relatively simple, such as the pure pine types, and only involve two or three critical species. The pine-hardwood and hardwood types involve more species and can become very complex. Since species composition is controlled by a number of interacting factors, including site quality, stand history, stage in succession, and proximity to seed sources, it is possible for species that are expected to be primary components to be reduced to a minor representation or even to be absent. It also is possible for species to appear as primary components which normally would be minor components or absent. These aberrations cannot be avoided. A further discussion of this subject is included in Section 7 on "Testing the Key."

In most cases, the cover types are related to the standard Society of American Foresters (S.A.F.) types (Anon., 1964), as is indicated in Appendix II, but they rarely are identical. In some cases, the types described have no S.A.F. equivalents. In general the S.A.F. types do not fit the species groupings found in the Alabama Piedmont. This is not surprising, however, since the S.A.F. types are based on continental ranges and must represent averages over many different versions of each type.

Management foresters probably will find that the types described in Appendix II are too detailed. However, any knowledgeable forester should encounter little trouble combining the defined types into groupings that are appropriate for his work.

TESTING THE KEY

Objectives of the testing program. – The primary objective of any test of a key should be to determine its validity. In other words, the test should indicate how well the key would perform if no errors were made in any decision based on the key.

A secondary objective of the testing program should be to determine whether or not the key is easy to use and, if not, where the decision points that present difficulty occur.

An extensive testing program was carried out to meet the first objective. No testing was done in terms of the second objective because of reasons given in detail in the following section.

Test program rationale. – The basic validity of an aerial photographic forest cover key can be evaluated only by sampling a portion of the forest stands in the region under study. Each of these stands would have to be visited to determine its species composition and to evaluate or measure on the ground the parameters used at the several decision points in the key. The parameter information then would be used to follow decision paths through the key. At the end of each decision path, the key provides an estimate of the species composition of the stand. This then would be compared with the actual species composition as determined in the field. Since there are many paths which might be used in a key and all should be evaluated for validity, the sample must include stands that are geographically widely dispersed, that represent a wide variety of species groupings, and that represent a wide spectrum of topographic sites. In order to keep the cost of the testing program within reasonable limits, the stands in the sample must be reasonably accessible, both physically and legally. Because of these constraints, it would be difficult to use probability sampling or any formal statistical design in the testing program. However, if the sampling is too selective, it will fail to represent the entire population. To avoid bias, the sample must be selected prior to the field work. This probably can best be accomplished using index mosaics and aerial photographs. The mosaics would be used to lay out logical routes of travel while the photographs would be used to locate the sample stands.

The results of a testing program such as this would indicate error rates by conditions or by groupings of conditions, which would be point estimates of the true error rates. Valid confidence intervals could not be computed for these estimates because of the method of sampling. Nevertheless, the estimates should be of value because they indicate approximately where the basic strengths and weaknesses of the key occur. A testing program based on this reasoning was carried out, and the results are reported in the following section.

In order to obtain information regarding the ease of using the key it would be necessary to assemble a representative sample of the persons apt to utilize a key of this type and then have the members of this sample estimate the species compositions of a series of stands by means of this key. The actual compositions of these stands would have to be determined in the field. Error rates, by decision paths, resulting from this test could be used as a measure of the ease of using the key.

As in the case of the validity test, the sample set of stands should include as many different cover types as possible and should occupy as many different site types as possible. If this is done the probability would be high that most, if not all, the decision paths would be explored and that most, if not all, the points of ambiguity would be found by the testers.

It would be possible to develop a sampling design that would yield estimates of these error rates. Implementing the design, however, would not be simple. The persons making up the testing team would have to be drawn from the population of potential key users, but the team could not include anyone who had been involved in developing the key. The bulk of the team would have to consist of persons not employed by the developing organization (Auburn University), and their participation would be at the pleasure of their employers. Experience with other key testing programs (Parker and Johnson, 1969; Northrop and Johnson, 1970) indicates that some organizations are willing to make certain of their personnel available for such purposes. Understandably, the time that these organizations are willing to allot to this type of activity is quite limited. Since the amount of time needed to test a key adequately is relatively great, particularly if the testers are to be made familiar with the key and its terminology, it is almost impossible to assemble a team to do the work. As a result, no formal attempt was made to recruit a team to test this key for ease of use.

On the other hand, once the preliminary key had been assembled, it was continually subjected to testing and revision. Much of this testing was done by the persons responsible for the project but, in addition, a number of other persons within the University community were asked to try the key and to offer suggestions for possible revisions. This was done at different stages in the development of the key. No numerical records were kept of these attempts. However, the comments generated by this process received attention, and the key was modified in response to them. This process undoubtedly has made the key easier to use than it otherwise might be.

Other useful constructive criticism was offered by undergraduate students in a class in forest photogrammetry, which was assigned an exercise involving the use of a relatively late version of the key. The results of this exercise are discussed in the following section.

Test results. – A test of the validity of the key was carried out using the ideas developed in the preceding section. Approximately 200 stands were chosen for ground examination. These were located on index mosaics and were distributed over the entire Piedmont Forest Habitat Region. Ten of these stands were in the Devil's Backbone area and the remainder were evenly divided between the Ashland and Opelika Plateaus. An attempt was made to reach each one of these stands. In some cases, however, the stands were in areas posted against trespassing and the postings were respected. In other cases the stands had been profoundly altered since the time of photography by cutting, burning, or other actions and, consequently, were not usable. These forces of attrition brought the number of usable stands down to 133. These were found and evaluated. Later the ground observed parameters were used in conjunction with the key to arrive at estimates of the species compositions. These estimates were compared with actual stand compositions. The results are summarized in Table 1.

As can be seen from the evidence in Table 1, the key functioned without error with respect to bottomland conditions. It would be presumptuous to infer from this that the key is infallible under these conditions. However, it apparently works very well.

Site conditions in the uplands are more variable than in the bottomlands and this is reflected in the error rate associated with the uplands. This error rate is on the order of 14 percent. This compares favorably with other aerial photographic forest cover type keys, particularly when the cover types are as finely divided as in this case. If one were to analyze the field data, it would be evident that in most of the cases where errors occurred the stands in question were borderline cases in respect either to their species compositions or to their topographic positions. Such errors might be called near misses and are probably not serious.

There were a few instances where no claim could be made that the errors were near misses. For example, both errors in the monadnock category resulted from samples falling on monadnocks in eastern Lee County in the area around Salem Mountain. These monadnocks are not typical. They were formed from quartzite and provide exceptionally poor sites. As a result the H(1) cover type is found extending all the way from the crest to the base level instead of only from the crest to somewhere around midslope. In another instance, shortleaf pine[2] was found dominating the canopy of a stand on the extreme lower slope of the north-facing, gently sloping, broad

TABLE 1. RESULTS OF THE TESTS MADE TO EVALUATE THE VALIDITY OF THE KEY

Condition	Number of stands evaluated	Number of errors[1]	Error rate[2]
			Pct.
Bottomland sites			
Branchheads			
Ashland	2	0	0
Opelika	2	0	0
Coves			
Ashland	1	0	0
Small streambottom			
Ashland	8	0	0
Opelika	13	0	0
Major streambottom			
Ashland	3	0	0
Opelika	1	0	0
Upland sites			
Devil's Backbone	4	1	25
Monadnocks	19	2	11
Peneplane hills-broad-gentle side slopes (or small hills-narrow-gentle side slopes)			
Ashland	14	3	21
Opelika	18	1	6
Peneplane hills-broad-steep side slopes (or small hills-narrow-steep side slopes)			
Ashland	27	3	11
Opelika	9	2	22
Peneplane hills-narrow-gentle side slopes			
Ashland	1	1	100
Opelika	1	0	0
Peneplane hills-narrow-gentle side slopes			
Ashland	4	1	25
Opelika	6	0	0
Totals			
Bottomland	30	0	0.0
Upland	103	14	13.6
Overall	133	14	10.5

[1] An "error" occurred when the actual species composition of the stand did not fit the description of the cover type indicated by the key.

[2] The "error rate" refers to the percentage of the total number of stands tested in a condition class whose species compositions were incorrectly identified.

[2] See Appendix III for scientific names of species mentioned in this publication.

crested peneplane hill in the Opelika Plateau. This is a most unusual situation in that loblolly pine is normally found under these conditions. There is no known explanation for this abnormal situation. Fortunately, anomalies of this sort are not common and should present few problems to users of the key.

As mentioned earlier, the members of an undergraduate class in forest photogrammetry were given an assignment involving the use of the key. This was done when the key was in a relatively late stage in its development. Sixteen students took part in this exercise. Each was given a copy of the key and was told to familiarize himself with the key and its use. Each student was given a set of four unknown stands to evaluate. Each student prepared a separate report in which he recorded every decision made in the course of reaching each conclusion. Each of the 64 stands was examined in the field by the instructor, and the students' conclusions were compared with the actual cover types.

A high rate of errors was found. The record of decisions reached at each step made it possible to reconstruct the paths followed in evaluating the stands. Each incorrect decision was studied to ascertain the cause of the error. As might be expected, some of the errors were caused by ambiguities in the key; and the key was further modified in an attempt to remove these ambiguities. A few of the errors were caused by borderline species compositions, locations adjacent to subdivision boundaries in the keys, or percentages of dark crowns. One clear-cut error in the key was exposed and corrected. All of the foregoing errors can be attributed to the key. Their number was small.

The preponderance of errors could be attributed to mistakes of the students. The decision chain records indicate an inordinately high rate of blunders. Considering the attributes of an ideal interpreter, one can easily perceive causes for the blunders. Ideally, the user would be thoroughly familiar with the key and would have a good understanding of all the terms used in the key. In addition, he would be capable of making all measurements or estimates (e.g., slope gradients) required by the key; he would be sufficiently familiar with local silvics that he would likely sense a blunder was in the making; and, lastly, he would be committed to doing a good job. The students who carried out this exercise did not fit this description at all closely. Most treated the exercise merely as a routine hurdle toward achieving an academic grade and expended a minimal effort in preparation. In addition, they were careless in assessing parameters controlling the decision making process. Stated in different words, they were not familiar with the key and their efforts to become familiar with it were minimal. Since they had demonstrated good stereoperception in previous exercises, all of the students were capable of measuring or estimating slopes from the photographs. The errors in slope gradients must be attributed largely to carelessness. Although many of the students were not well acquainted with forest conditions in the Piedmont, they could have avoided many of their blunders by reviewing their previous studies in silvics and silviculture. Once again, student's mental attitude toward the exercise undoubtedly influenced their performance. It is not intended to imply that none of the students performed well in this exercise. There was a definite relationship between accuracy and the student's general scholastic performance. Good students were much more accurate than poor students. Superior performance in the exercise, like superior scholastic performance, probably reflects more thorough preparation.

It cannot be emphasized too strongly that users of this or any photo-interpretation key, must be amply motivated or their results will be unsatisfactory. This statement is as true of interpretation in real-life work as in a student exercise.

DESCRIPTION OF THE VARIABLES

Geology. – A general geologic map of the Alabama Piedmont appears in Figure 2. The entire Piedmont province is characterized by igneous and metamorphic rocks (granites, gneisses, schists, phyllites, and quartzites) that have undergone distortion and leveling by erosion through many eons. Within Alabama, the province has been divided into two parts, the Opelika and Ashland Plateaus (Figure 1). The two plateaus have different geologic structures and surface configurations, which lead to differences in vegetative distribution. This difference is recognized in the key.

At one time the Opelika plateau was a relatively mature peneplane with an almost flat surface traversed by slow moving streams. Later, the area was uplifted, with the result that stream gradients were increased and downward cutting by the streams accelerated. At present the surface ranges in altitude from 500 to 800 feet above sea level. The hills are low with only a few monadnocks (e.g., Salem Mountain and the main ridge in Chewacla State Park, both in Lee County) standing higher than the general level of the peneplane hills. The range in relief among the peneplane hills is about 50 feet, rarely exceeding 100 feet. Relief of the monadnocks is more pronounced, but the maximum range is only about 200 feet. Hills or ridges in some areas tend to be linearly oriented in a northeast-southwest direction, reflecting geological structure. However, over most of the Opelika plateau the stream pattern is dendritic. Although the stream gradients are generally gentle, there are few poorly drained or swampy areas except where beavers have constructed dams. No major stream traverses the Opelika plateau, but it is bounded on the east by the Chattahoochee River. Drainage from the plateau is into the Chattahoochee and Tallapoosa rivers.

In a geologic sense, the Ashland plateau is considerably more complex than the Opelika. Its surface is considerably rougher. The plateau lies at an altitude ranging from 500 to 600 feet in the southwest to somewhat more than 1,000 feet in the northeast. Monadnocks are numerous. The tendency toward linearization of geologic features is considerably stronger in the Ashland plateau than in the Opelika plateau, but extensive areas exhibit dendritic drainage systems. Poorly drained or swampy areas are rare here, also, even along the Tallapoosa River, which is the only major stream flowing through in the Ashland plateau.

The eastern outlier of the Wedowee Formation, which lies along the boundary between the Opelika and Ashland plateaus, is the site of the Brevard fault, a major geologic feature of the Piedmont. During development of the key it was found that vegetative distribution patterns in a portion of this area were strikingly different from elsewhere in the Piedmont. Consequently, this part of the Wedowee outlier was recognized as a third division of the Piedmont and was labeled the "Devil's Backbone" (see Figures 1, 2, 58, and 62) after a resistant quartzite ridge that lies within it (O'Neill and Valley, 1970). Essentially, the Devil's Backbone is a low monadnock, with Smith Mountain its highest point. The monadnock cuts across the eastern part of Lake Martin and terminates just south of Martin Dam. North of U.S. Highway 280, the Devil's Backbone conditions are patchy and are largely limited to the main ridge in the area shown on Figure 58. Topographic positions in the Lake Martin area are difficult to determine because the impounded water hides much of the hillsides. The proportion of a slope hidden by water must be estimated by persons using this system of forest cover photo-interpretation.

Peneplane hills and monadnocks. – Peneplanes are areas where geologic erosion has reached an advanced stage. The surface is generally almost flat. When there is a subsequent uplifting of the area so that the surface is tilted, streams begin to flow faster and to cut deeper into the peneplane surface. The stream pattern in such a case is dependent on the structural character of the area over which they flow. If the underlying strata are essentially horizontal they have little influence on the stream pattern and the resulting stream distribution resembles a diagram of a hardwood tree crown, giving rise to the term, "dentritic" (see Figure 3).[3] If the underlying strata had been distorted by tilting or folding prior to the peneplaning process, so that they lie at appreciable angles to the horizontal, a surface results that is characterized by a series of more or less parallel ridges. In turn, a parallel stream pattern results. In other areas, a series of parallel faults may result in streams following more or less parallel paths. There are still other areas in which the streams may exhibit parallelism because they are flowing between hills formed around linear rock intrusions, such as dikes. Regardless of cause, stream patterns exhibiting such parallelism are referred to as "lattice" patterns (see Figure 4).

The hills formed by the dissection of the peneplane have a more or less common elevation because their crests are part of the original peneplane surface. These hills are called *peneplane hills* in this key. Figure 5 shows a portion of a peneplane where the streams are cutting downward relatively slowly. Figure 6 shows a more strongly dissected peneplane where the streams are cutting downward more actively than those in Figure 5. In both Figures 5 and 6, the crests of all the hills are at about the same elevation. As far as this key is concerned, this places them in the peneplane hill classification. In an area undergoing the process that leads to the development of a peneplane there may be rock formations that are more resistant to weathering and erosion than are the majority of the formations. These resistant formations may at one time have been horizontal strata which, due to tilting or folding and subsequent erosion, have been brought to the surface; or they may be masses of intrusive material. As the peneplane surface develops these resistant masses erode more slowly than the surrounding material with the result that they appear as hills standing above the general peneplane surface. These hills are *monadnocks.* If the peneplane is then tilted and downcutting of the streams takes place, peneplane hills are formed with the monadnocks interspersed among them. Figure 7 shows a monadnock that forms an elongated ridge. The bulk of the monadnocks in the Piedmont show a tendency toward such linearization, with a general northeast-southwest trend. However, some are non-linear, as is shown at B in Figure 8. When monadnocks are small, it may be impossible for non-geologists to distinguish them from peneplane hills. This is not critical insofar as this key is concerned because their vegetative distribution patterns are usually similar to those of peneplane hills. In other words, they should be treated in the key as if they were peneplane hills. The portions of the Piedmont where monadnocks are *more apt* to occur are shown on the maps in Appendix III. It must be emphasized that not *all* the hills in these areas are monadnocks. The maps show areas where the observer should expect to find monadnocks and also show the areas where it is unlikely for monadnocks to occur.

The drainage pattern usually is strongly influenced by monadnocks, as can be seen in Figure 9. If the monadnock is linear the streams take on a lattice pattern. However, *the appearance of a lattice stream pattern does not mean that a monadnock is necessarily present.* As was explained earlier, although a lattice pattern indicates structural control, unless the hills formed from that structure have crests that are noticeably higher than the average level of hill crests in the area, a monadnock is not considered to be present. Figure 4 shows a lattice pattern in an area of linear peneplane hills.

Topographic positions on hills. – The upland sites, on both peneplane hills and monadnocks, have been divided into four classes: *crest, upper slope, middle slope,* and *lower slope;* as shown in Figure 10. The lower bound of the upland zone is the *base level,* which is the upper edge of the overflow area, if such exists, or the bank of the stream if no overflow area is present. The crest extends across the top of the hill and down to a point where the main downward slope of the hill begins.[4] The length of the slope between the base level and the lower edge of the crest is divided equally among the three slope classes, which are self-explanatory.

In the Lake Martin, Lake Jordan, and Lake Harding areas, the base level may lie deep under the water. Consequently, it is often difficult to define at the appropriate slope position in these areas. No rule is generally applicable, and the interpreter must depend on different clues for most situations and apply his best judgment.

The width of the crest and the degree of slope below the crest influence the soil and plant moisture regime and, thereby, the vegetative distribution pattern. Both have been taken into account in the key. Two crest width classes have been recognized, with the critical crest width set at 250 feet. Crests wider than 250 feet are referred to as "broad" crests, while those narrower than 250 feet are referred to as "narrow" crests (see Figures 7, 11, and 12). The vegetation pattern on peneplane hills with base areas (i.e., the area within the base level line) less than 50 acres (e.g., see the hills labeled B in Figure 12) seem to be independent of crest width and were found to resemble the patterns found on broad crested, large peneplane hills. This has been recognized in the key.

Figure 13 shows an area of peneplane hills and Figure 8 shows a monadnock where the slope classes have been delineated for illustrative purposes only. The interpreter should delineate mentally to determine the topographic position at which the unknown stand occurs. One must recognize that forest stands usually extend over more than one topographic situation and that a certain amount of averaging must be done. Although the key probably would be more accurate in classifying the cover on plots, if the interpreter uses good judgment, reasonable accuracy should be attainable with stands.

Slope of sides of hills. – Two slope categories have been recognized (see Figure 10): *gentle* (from 0 to 14 percent) and *steep* (15 percent or more). Figures 5, 6, and 7 show examples of such slopes as imaged on typical ASCS photography.

Aspect. – The key recognizes that the moisture regime and, therefore, the vegetation distribution pattern are influenced by the aspect of a hill. Theory and empirical evidence indicates that the coolest and dampest sites occur on the northeast facing slopes while the hottest and driest conditions are found on the southwest facing slopes. The axis of maximum effect is therefore located along the N 45° E-S 45° W line. The distribution of species is essentially symmetrical on either side of this line, as is shown in the hill patterns in Figures 44 through 53.

Bottomland sites. – The sites adjacent to streams and subject to overflow from time to time, i.e., those sites below

[3] The stereograms used in this publication have been constructed so that North is to the left.

[4] Another definition of the crest is the convex portion of the hilltop.

the base level previously described (see Figure 10), have been divided into five categories: those in the headwaters areas, as in Figures 3 and 9, that are essentially intermittent and are the primary collectors of overland water flow; those in the headwaters area in a cup or ravine (often referred to as a *cove*) and the stream usually is fed by springs, is not intermittent, still is small, as in Figure 14; those below the headwaters area that are less than 30 feet in width as shown in Figures 3, 4, and 9; those below the headwaters area that are 30 feet or more in width as shown in Figures 4, 15 and 16; and those on sand bars in or immediately adjacent to the stream as shown in Figure 17. Usually the headwaters streams have very narrow overflow areas and the vegetation associated with the stream occurs along the streambanks or only a short distance from them. On the photographs this often appears as a single line of crowns along the water course. Conditions in a cove depend on its size. Below the headwaters, the overflow zone widens with the stream. When the stream reaches a width of about 30 feet, the associated overflow zone usually becomes wet enough to support a different vegetative complex than is found higher up the stream. This has been recognized in the key. Sandbars usually are essentially virgin sites and are occupied by pioneer species such as black willow (see Figure 17). Consequently, they have been placed in a separate category. Black willow also occupies the deposition areas where streams enter impoundments (see Figure 18).

Photographic tone. – The most valuable photo-image characteristic for distinguishing between softwoods and hardwoods on black and white aerial photographs is photographic tone. Hardwoods, as a group, reflect more light than do softwoods, usually making them appear lighter in tone on photographic prints than softwoods. This tendency can be accentuated by the appropriate choice of photographic specifications.

The photographic specifications used by the ASCS fail to produce photographs that are ideal for forest cover identification. While the film and filter combination is acceptable, season of the year receives little if any consideration because the agency requires photography that will merely distinguish field from forest. Since the only seasonal condition that interferes seriously with its requirements is snow cover, most of the photographs made for the ASCS are taken in the summer in the North and in the late fall, winter, or early spring in the South. This latter period is the worst possible for taking aerial photographs that are to be used for forest cover evaluation because the hardwood leaves are dying, have fallen, or are just developing. Consequently, photographic tones associated with hardwood cover are subject to wide variations and have been given minimal weight in the key. Nevertheless, tone cannot be ignored completely since it is essential to the estimation of relative proportions of hardwoods and softwoods.

A further factor influencing photographic tone is contrast, which is defined as the range in grey tones, from the lightest to darkest, appearing on the print. When this range is short, i.e., the lightest tone is not much different from the darkest tone, the print is said to have low contrast and is termed a "soft" print (see Figure 19). When the lightest tones are nearly pure white and the darkest tones are nearly black, the print is said to have high contrast and is termed a contrasty, or "hard," print (see Figure 20). Contrast is controlled in the printing process, and the usual objective is to choose a contrast level that will reveal the maximum detail. If the contrast is not optimum, whether the print be too soft or too hard, detail, i.e., information, is lost. In ordering photographs from the ASCS, one is given no opportunity to specify the contrast level, and the ASCS makes little or no effort to provide an optimal contrast. Only rarely does the contrast meet the desires of a forester interpreting the photos. Tonal differential between hardwoods and softwoods is often minimal making the photo-interpretation problem more difficult than it otherwise would be.

The key in this publication recognizes three tonal situations, based merely on the proportion of dark (softwood) crowns in the stand canopy. (1) 70 percent or more of the crowns dark grey; (2) 30 to 70 percent of the crowns dark grey; and (3) less than 30 percent of the crowns dark grey. Neither season of photography nor contrast level of the print greatly effects the detectability of the dark grey crowns. However, the evaluation of the hardwood component of the canopy is strongly influenced by these factors.

In the fall, leaves of deciduous trees decline in vigor and die in a pattern that is far from uniform, leaving some crowns visible and others invisible. Underestimation of the hardwood proportion results. In addition, tonal differences between hardwoods and softwoods are reduced during this period, particularly when the contrast level is low, see Figure 21.

In the winter when the deciduous trees bear no leaves, the crowns are invisible on photographs and the tone is a reflection of ground cover and has little or no relation to the hardwood trees themselves. The only evidence that trees are present are shadows. When the shadows of bare trees fall clear on a smooth surface, they may provide good evidence for evaluation of the forest cover (see Figure 22). The shadows are seldom so clear (see Figure 23), but they can usually be used to estimate the relative density of the hardwood component.

Some broadleaved tree species (e.g., sweetbay) are evergreen, and some (e.g., southern red oak) hold their dead leaves until the new leaves appear in the spring. This causes no problem as long as the photographs are taken on panchromatic film, because both live and dead hardwood leaves usually appear lighter on such photographs than the softwood crowns. However, black and white infrared film provides little difference in tone between softwood crowns and dead hardwood leaves.

Tonal differences between hardwoods and softwoods appear to be at their maximum after the leafing out process is essentially complete but before the leaves are fully mature. There should be no difficultly in classifying a stand into one of the tone classes from photographs made then. Unfortunately, ASCS photography in the South rarely is taken this late in the spring and dependence must be placed on a combination of tone and shadows, see Figure 24.

Different stands having the same ratio of dark to light crowns may differ considerably in appearance because of differences in stand density. Figures 25 to 40 are stereograms that show examples of the three different tone classes with different stand density levels. Examples are also shown where the hardwood component must be evaluated from shadows.

Plantations. – Pine plantations are found throughout the Piedmont. Though most are composed of loblolly pine, several species have been planted. Trees are often planted on sites where they would be unlikely to occur naturally. For this reason, the key does not distinguish between species of planted pines because it is based on natural occurrence patterns. When these are violated the key is invalidated.

Young pine plantations are characterized by a comparatively high uniformity in stand density and tree height. In addition, the rows often can be distinguished, see Figure 41. As the plantations get older, the uniformity of density and tree size remain, but the rows become less and less distinct, see Figures 42 and 43. Nevertheless, a plantation is seldom hard to identify.

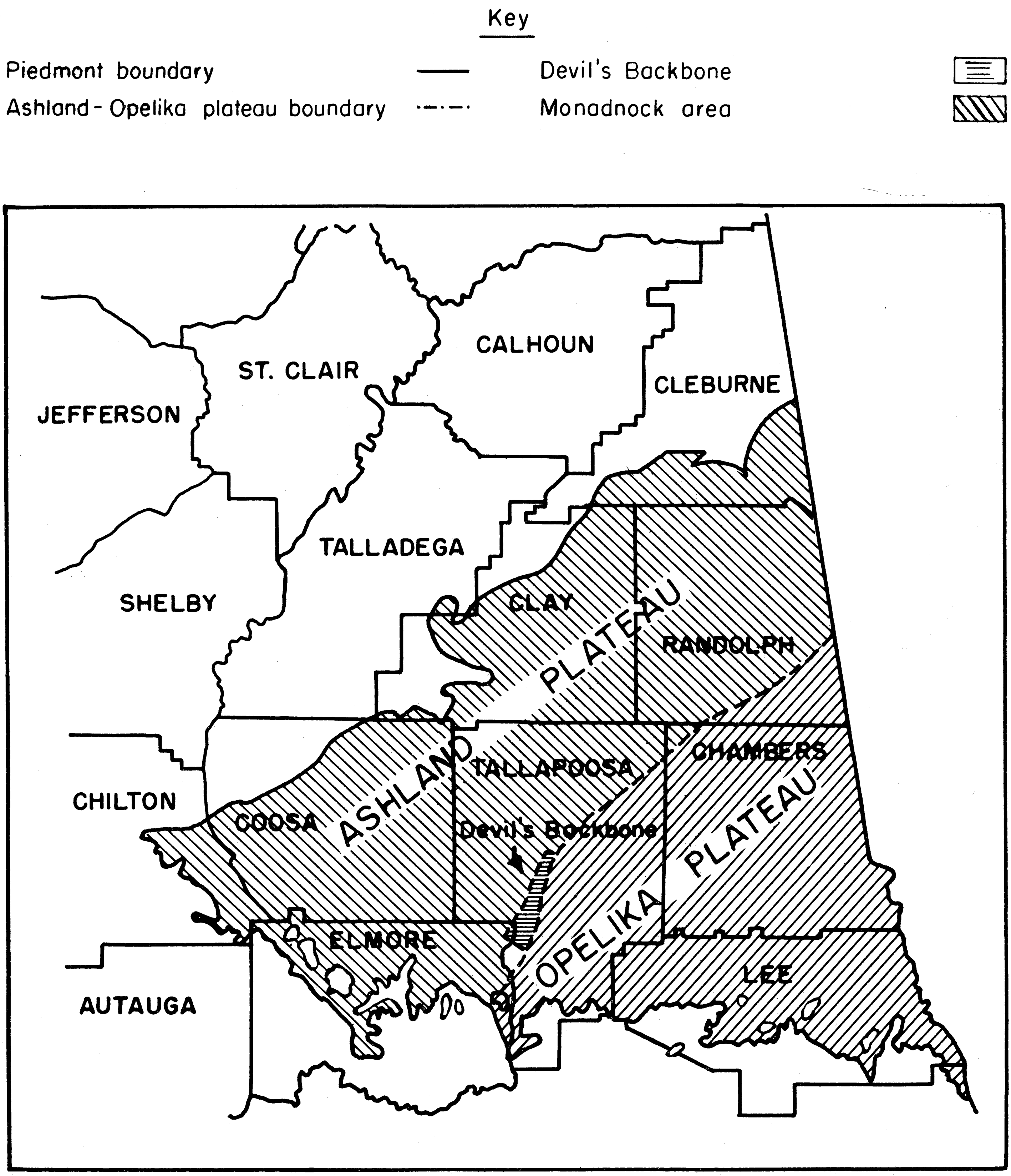

FIGURE 1. Map of the Piedmont physiographic province in Alabama showing the Ashland and Opelika plateaus, and the Devil's Backbone. (Modified from: Johnston, 1930.)

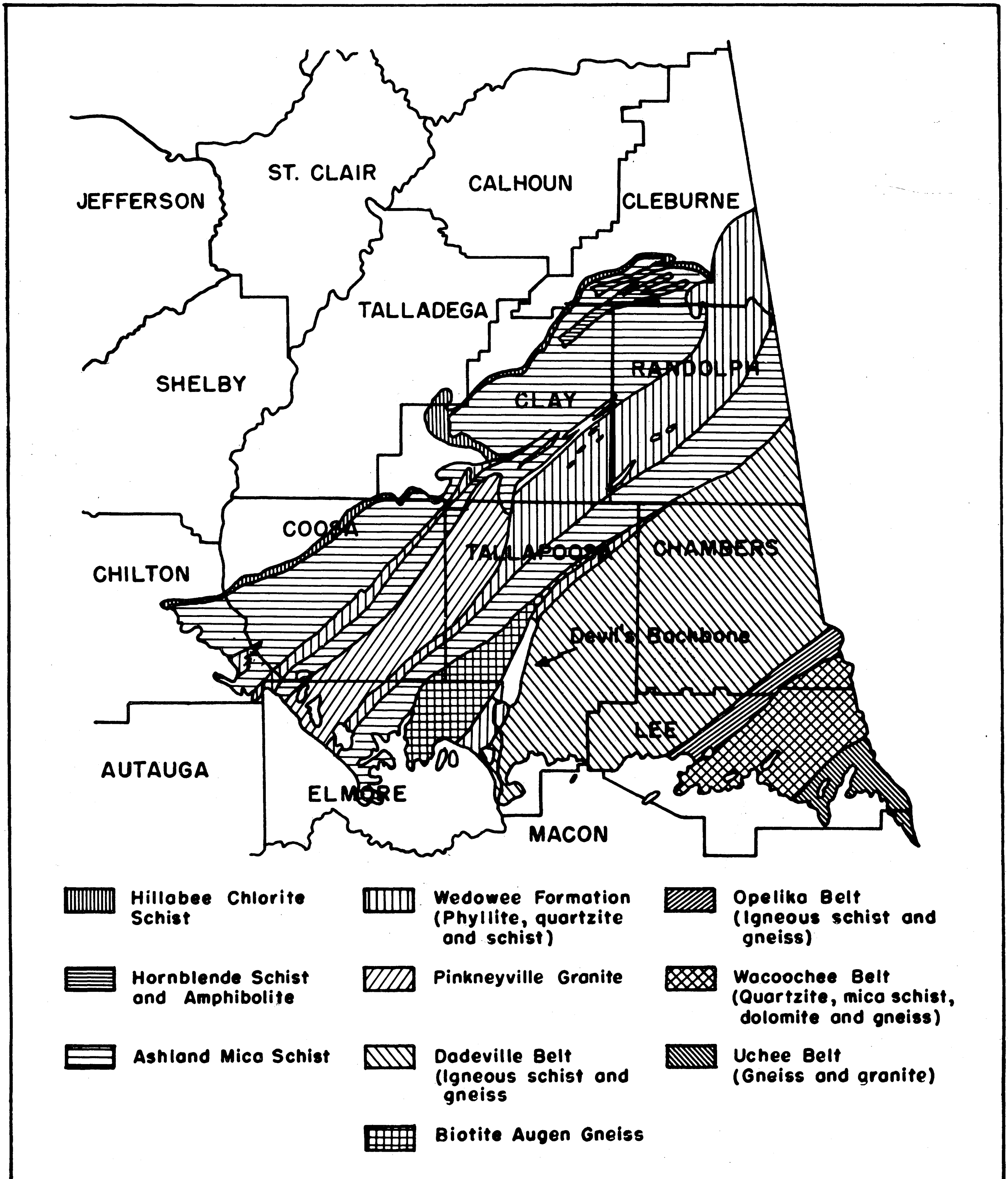

FIGURE 2. Map of the Piedmont physiographic province in Alabama showing the major geologic formations. (From: Adams, et al, 1926; and Deininger, et al, 1964.)

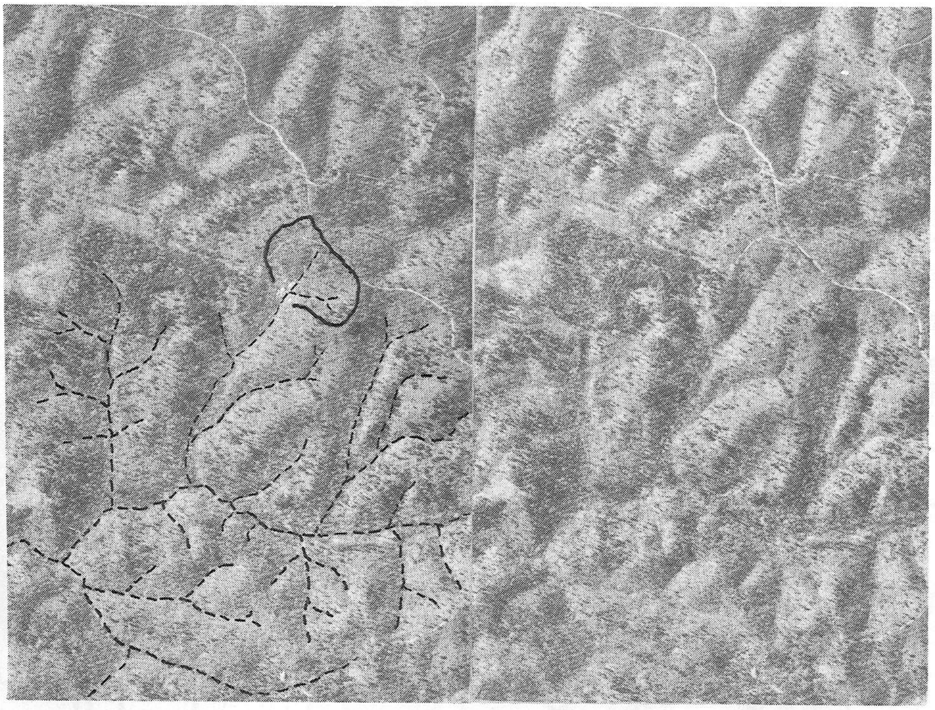

FIGURE 3. Stereogram showing dendritic drainage pattern in an area of peneplane hills. (Randolph County.) Part of the drainage system has been emphasized with dashed lines. The headwaters area of one of the streams is outlined. All of the streams are less than 30 feet wide. (HT-1EE-55,56)

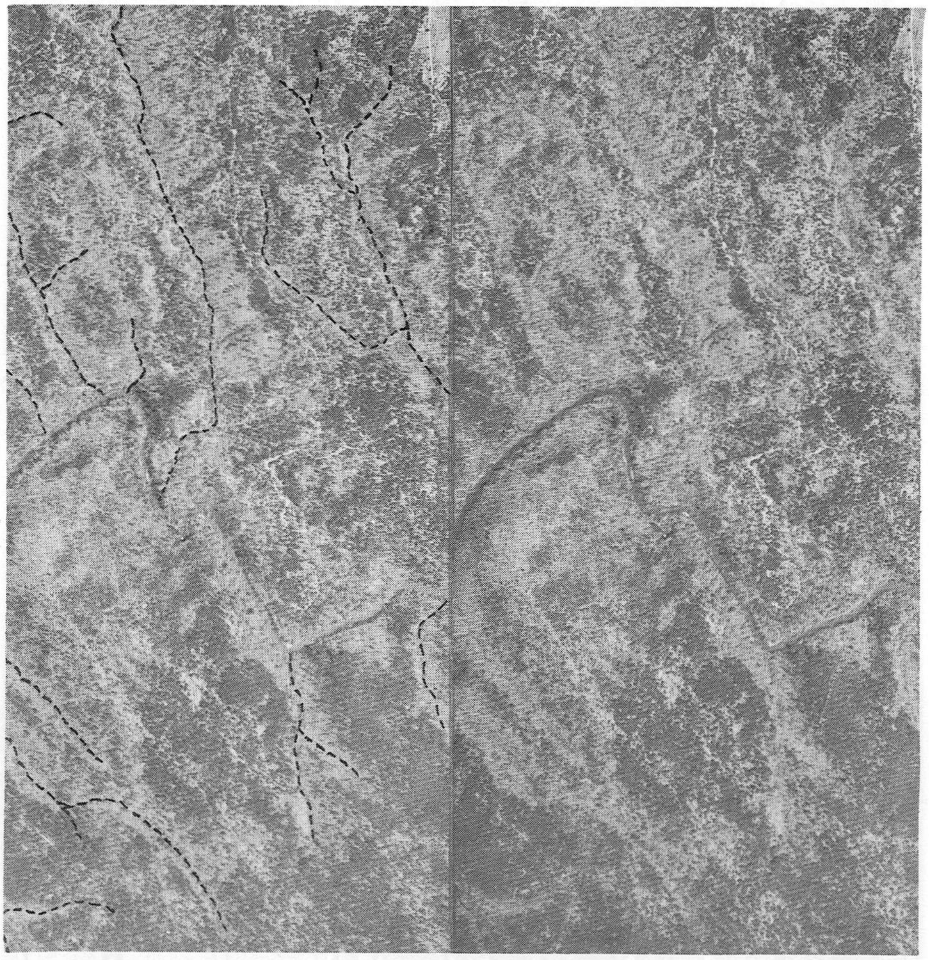

FIGURE 4. Stereogram showing lattice drainage pattern in an area of peneplane hills (Lee County). Part of the drainage system has been emphasized with dashed lines. The major stream is more than 30 feet wide and all the dashed streams are less than 30 feet wide. (ED-1EE-252,253)

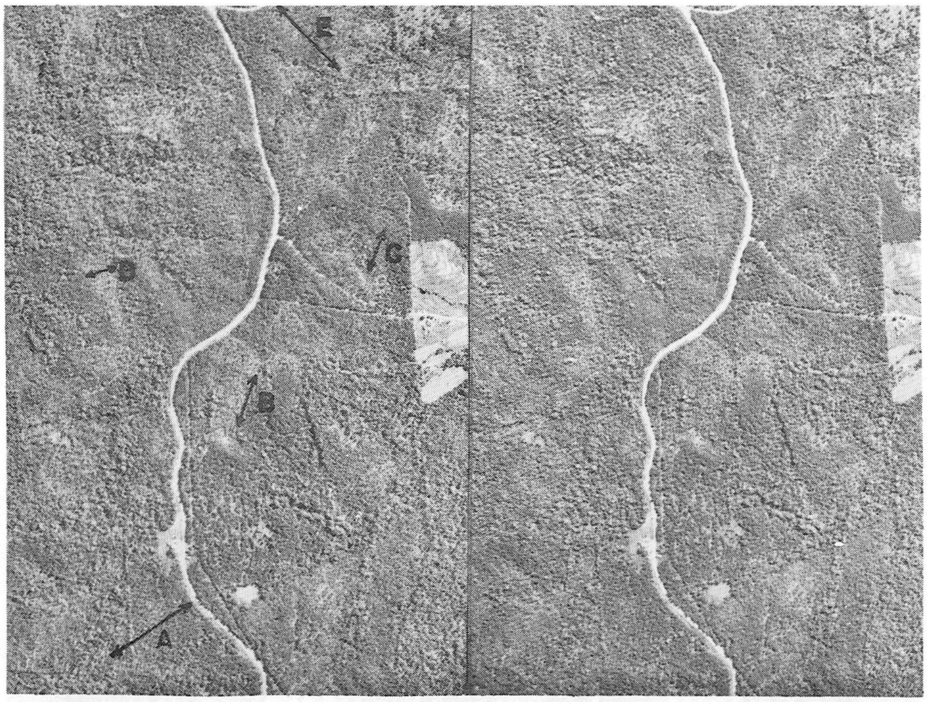

FIGURE 5. Stereogram of a gently rolling or undulating peneplane (Tallapoosa County). All of the hilltops have about the same elevation. Slope gradients are: A, 4%; B, 6%; C, 12%; D, 14%; and E, 3%. (APC-1JJ-36,37)

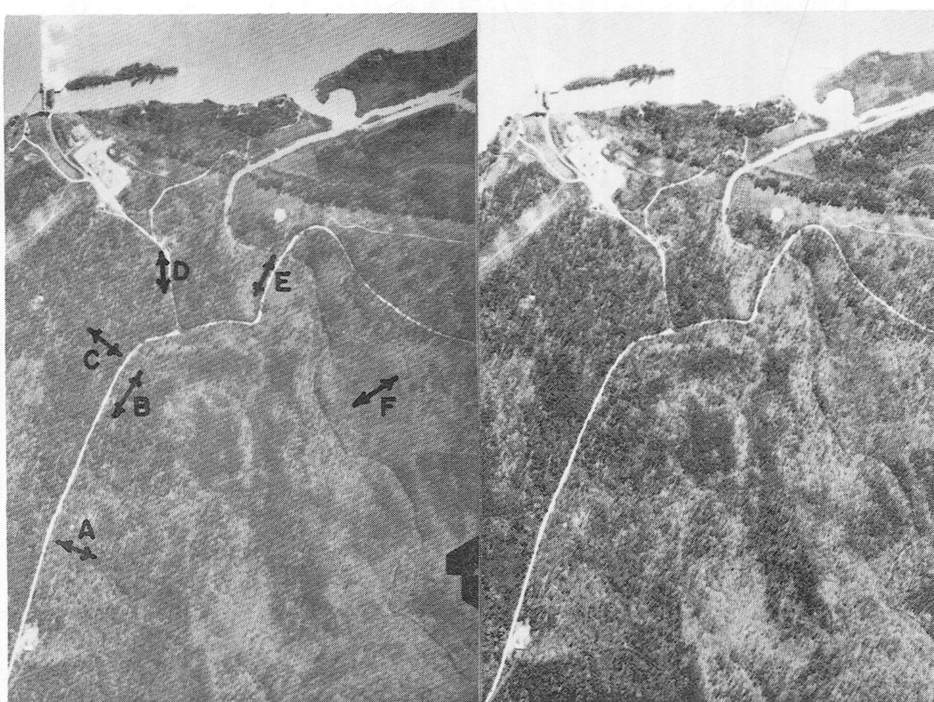

FIGURE 6. Stereogram of a more strongly dissected peneplane (Lee County). Crests of the major hills have about the same elevation. Slope gradients are: A, 4%; B, 4%; C, 22%; D, 9%; E, 12%; and F, 28%. (ED-2EE-49,50)

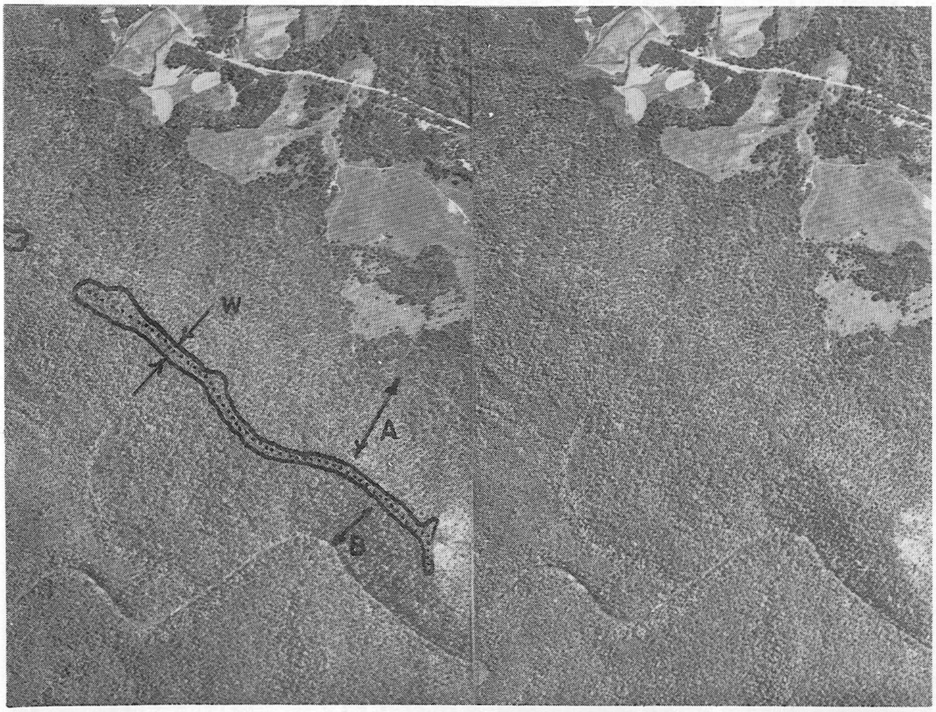

FIGURE 7. Stereogram showing a linear monadnock (Clay County). The crest is narrow (width measured as at W) and the slope gradients are steep, 35% at A and more than 40% at B. Note the typical NE-SW trend of the ridge. (GV-1JJ-181-182)

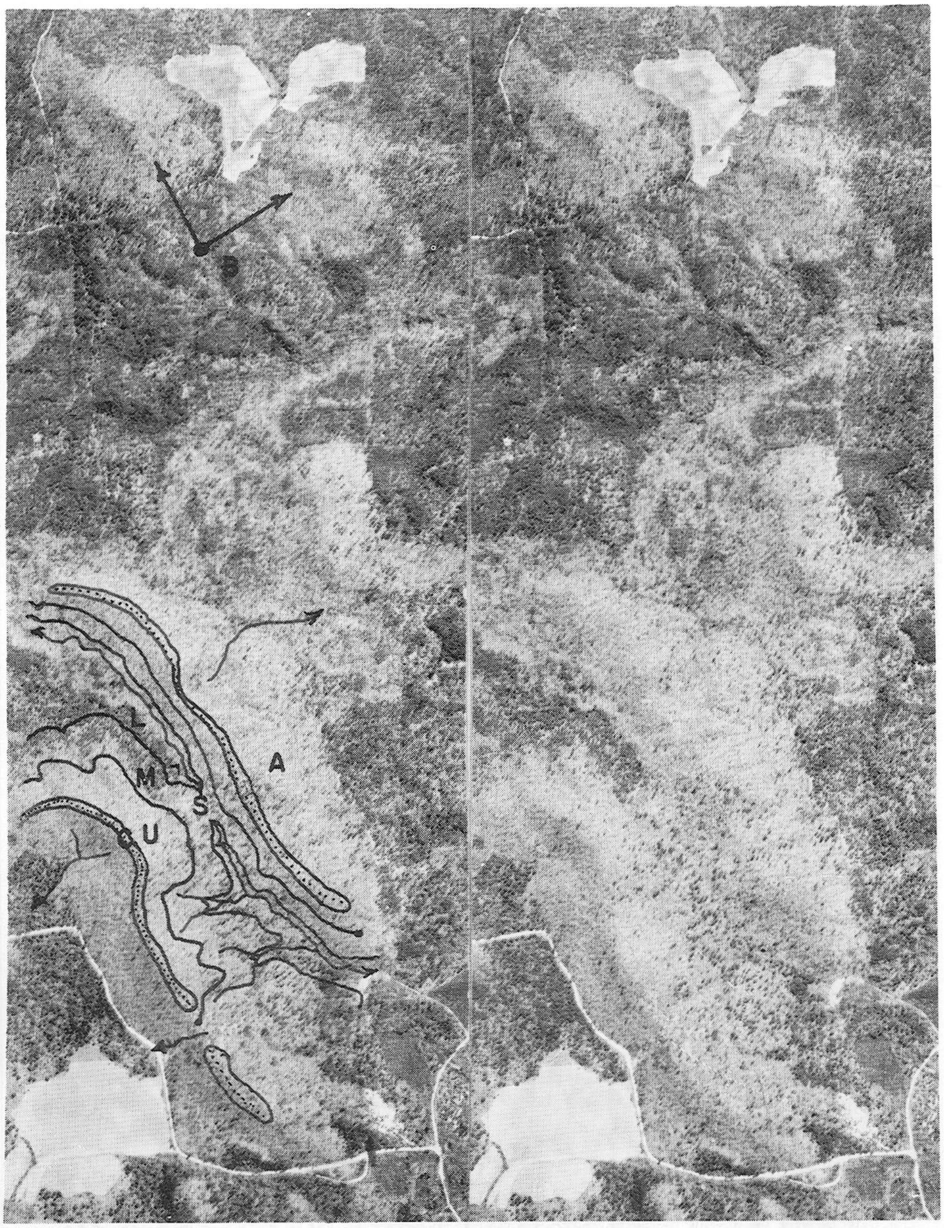

FIGURE 8. Stereogram showing a group of monadnocks (Lee County). The two linear monadnocks (A) are joined forming a saddle at (S). The two cone shaped monadnocks at (B) are representative of the smaller monadnocks which may be difficult to distinguish from peneplane hills. The topographic positions are outlined on the larger monadnocks: (C) crest, (U) upper slope, (M) midslope, and (L) lower slope. (ED-2EE-119,120)

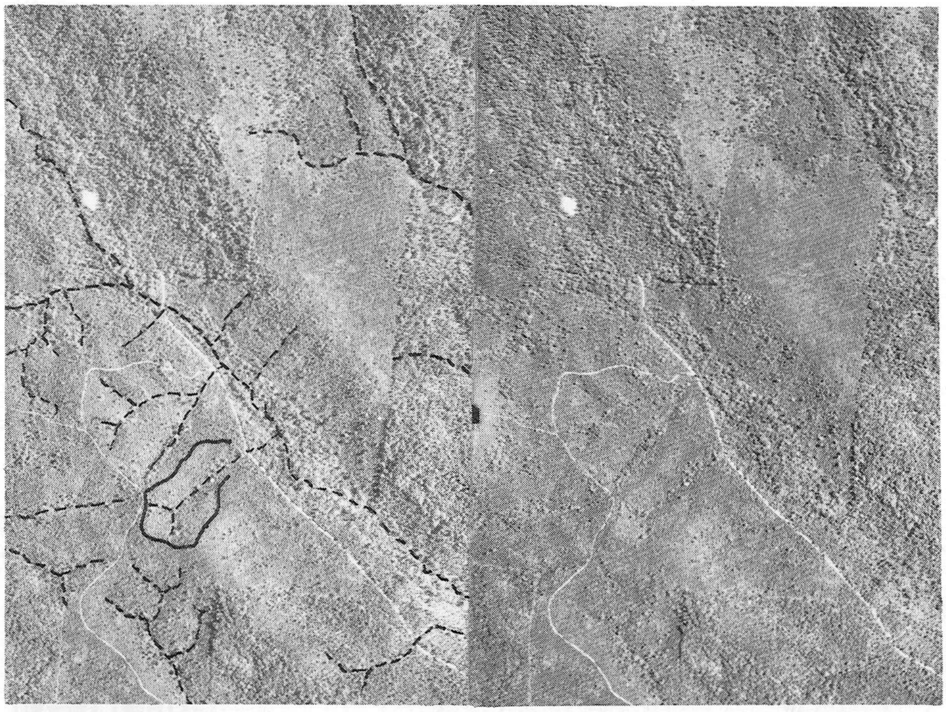

FIGURE 9. Stereogram showing lattice drainage pattern around a linear monadnock (Clay County). The headwaters areas of one of the streams is outlined and a portion of the drainage system has been emphasized with dashed lines. All of the streams shown are under 30 feet in width. Note how the mass of the monadnock strongly influences the drainage pattern. (GV-2JJ-74,75)

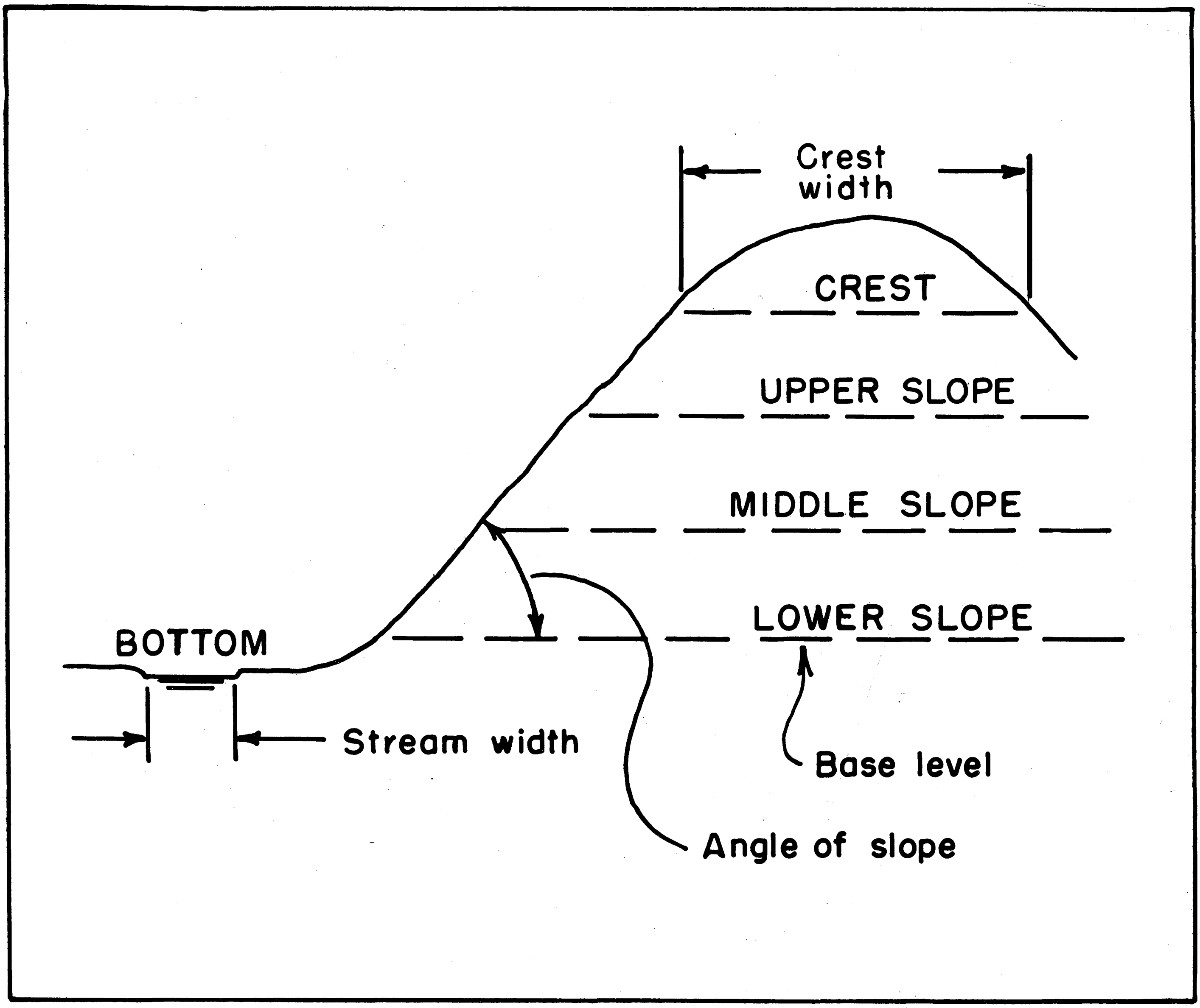

FIGURE 10. Idealized cross-section of a hill and valley showing the typographic positions, the base-level, and the crest and bottomland widths.

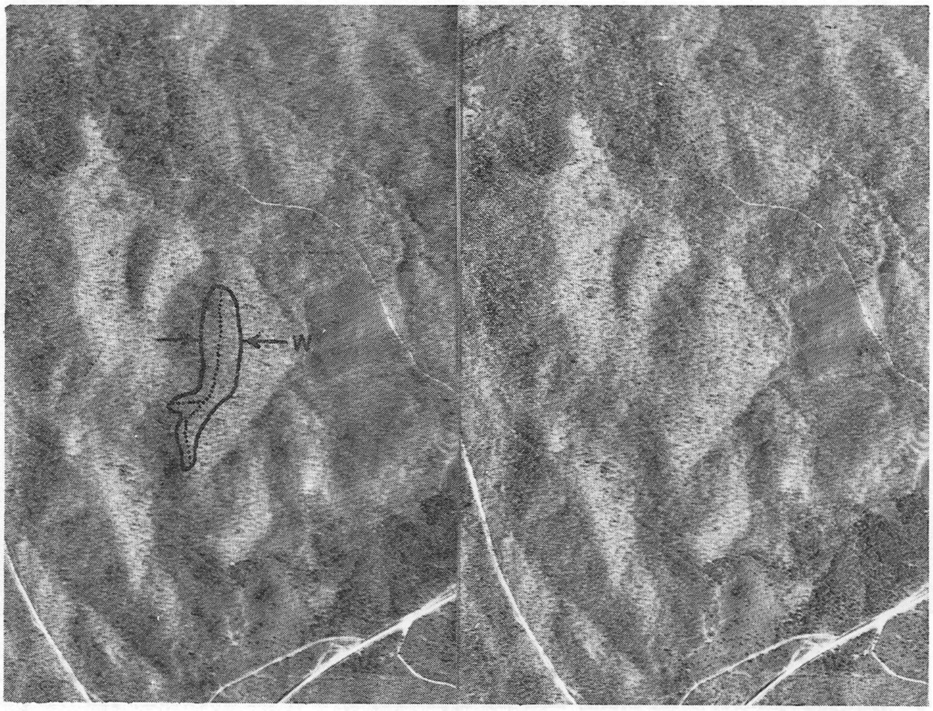

FIGURE 11. Stereogram of a broad-crested peneplane hill (crest 250 feet or wider, as measured at W) (Randolph County). (HT-2EE-213,214)

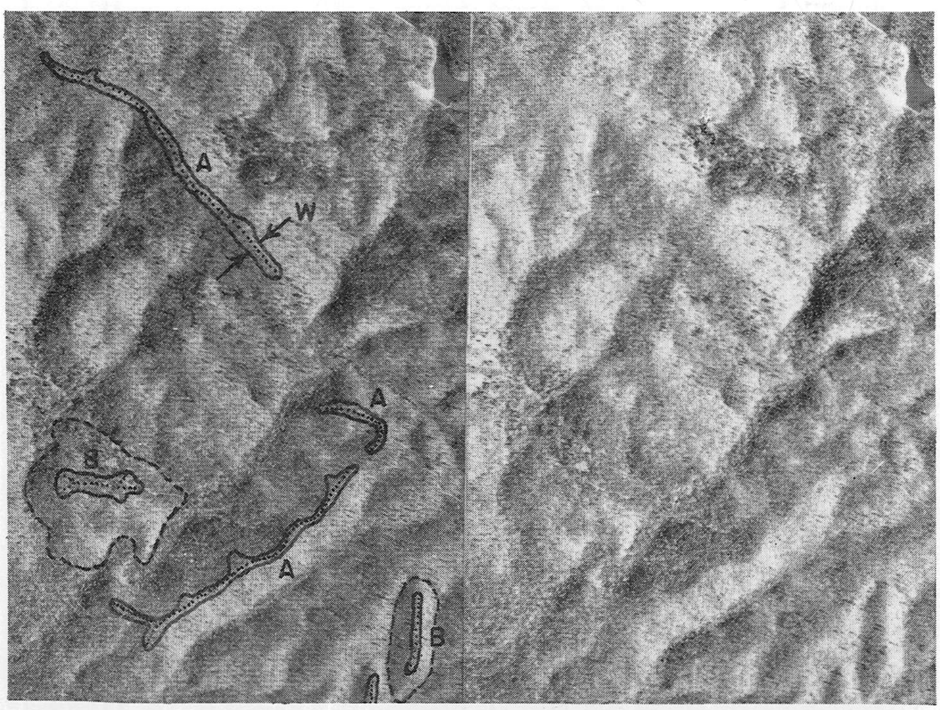

FIGURE 12. Stereogram showing: (A) peneplane hills with narrow crests (width measured as at W); and (B) small peneplane hills with base areas (see dashed lines) less than 50 acres. Vegetational distribution on the small hills is similar to the distribution on broad crested hills (Randolph County). (HT-1EE-53,54)

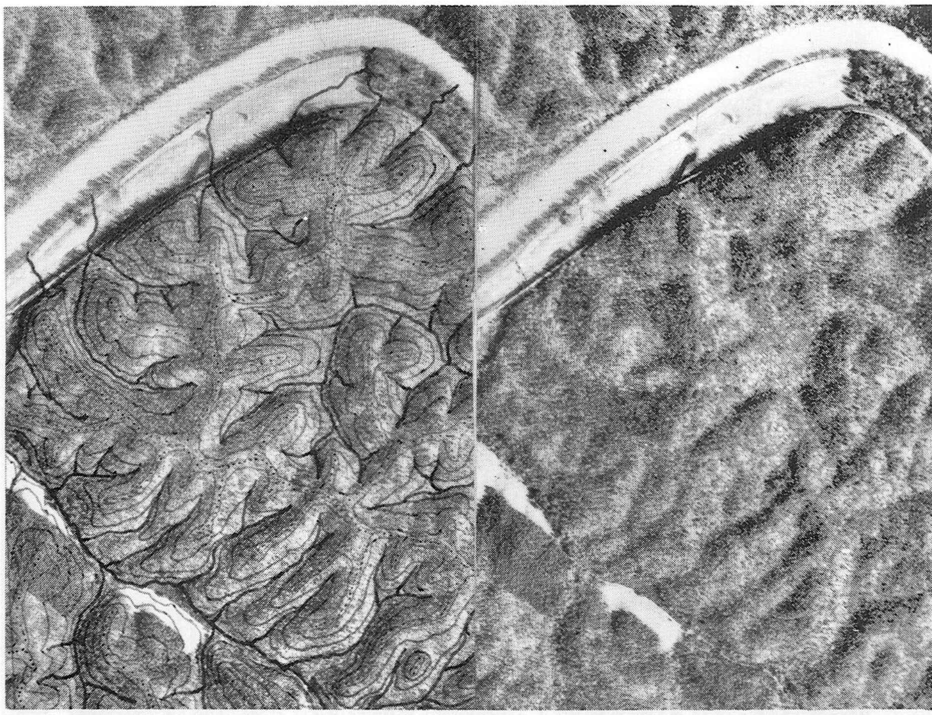

FIGURE 13. Stereogram of peneplane hills with the upland topographic positions delineated (Randolph County). Dotted lines indicate the crestlines are water divides, the highest solid lines delineate the crests, next the upper slopes, then the midslopes, and last the lower slopes. (HT-1EE-122,123)

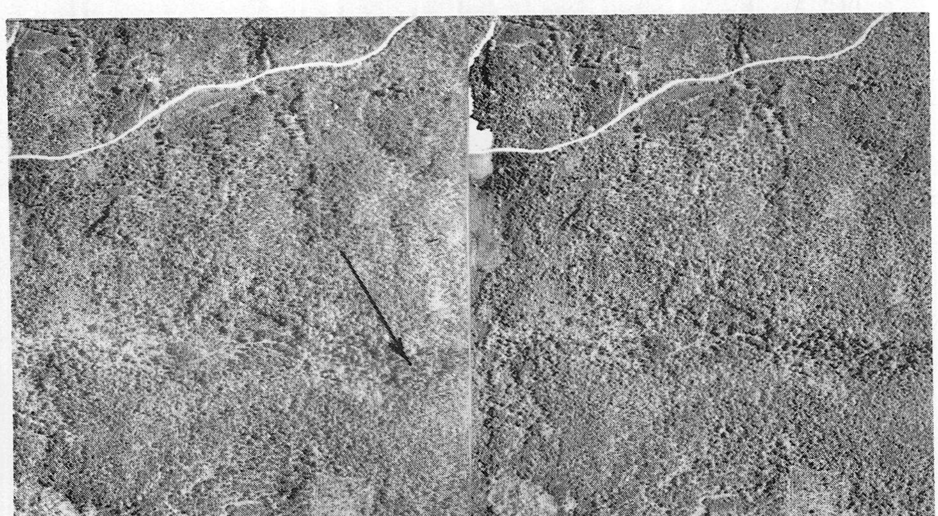

FIGURE 14. Stereogram showing a cove (Clay County). This is an exceptionally fine example. Most coves are smaller and less distinct. (GV-2JJ-100,101)

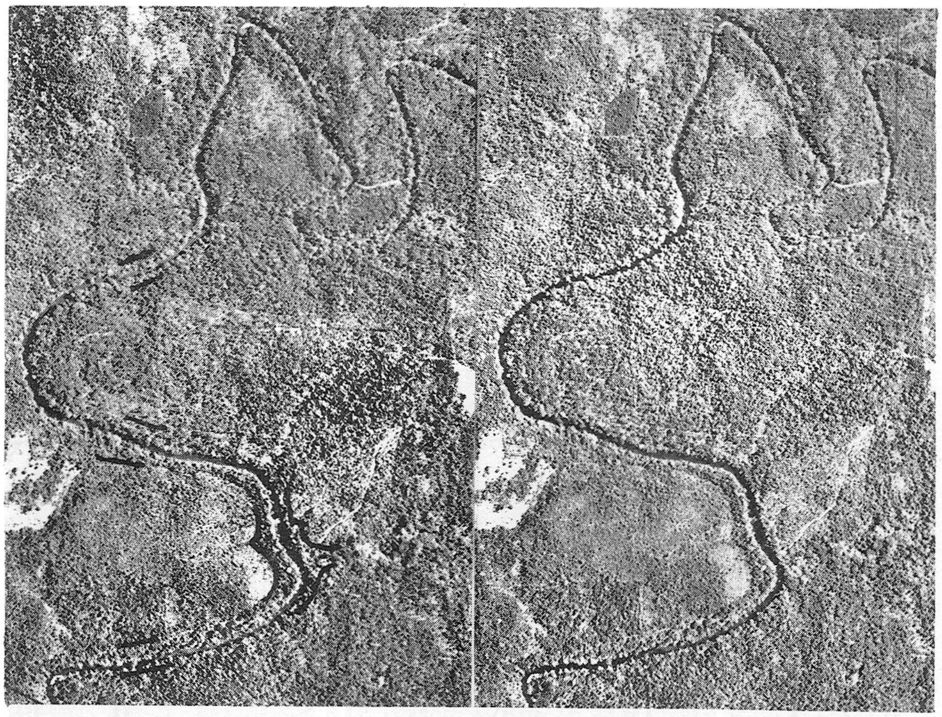

FIGURE 15. Stereogram of a stream that is somewhat wider than 30 feet (Tallapoosa County). The extent of the floodplain is marked at several points. (APC-1JJ-212,213)

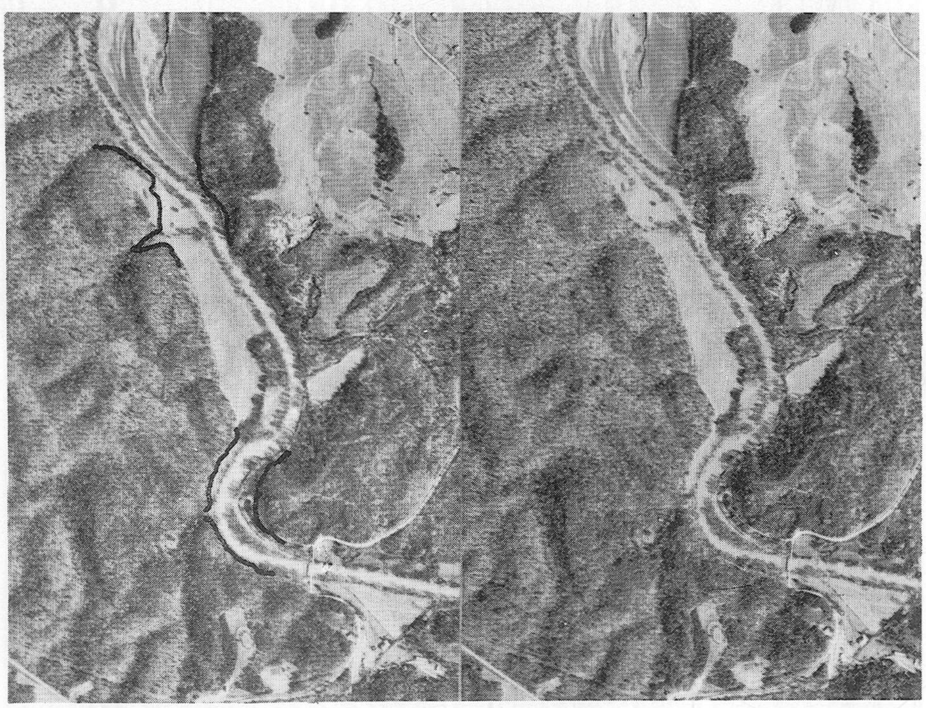

FIGURE 16. Stereogram showing a relatively major stream, the Little Tallapoosa River (Randolph County). The extent of the floodplain is marked at several points. Extent of cultivation often indicates width of the floodplain. (HT-1EE-48,49)

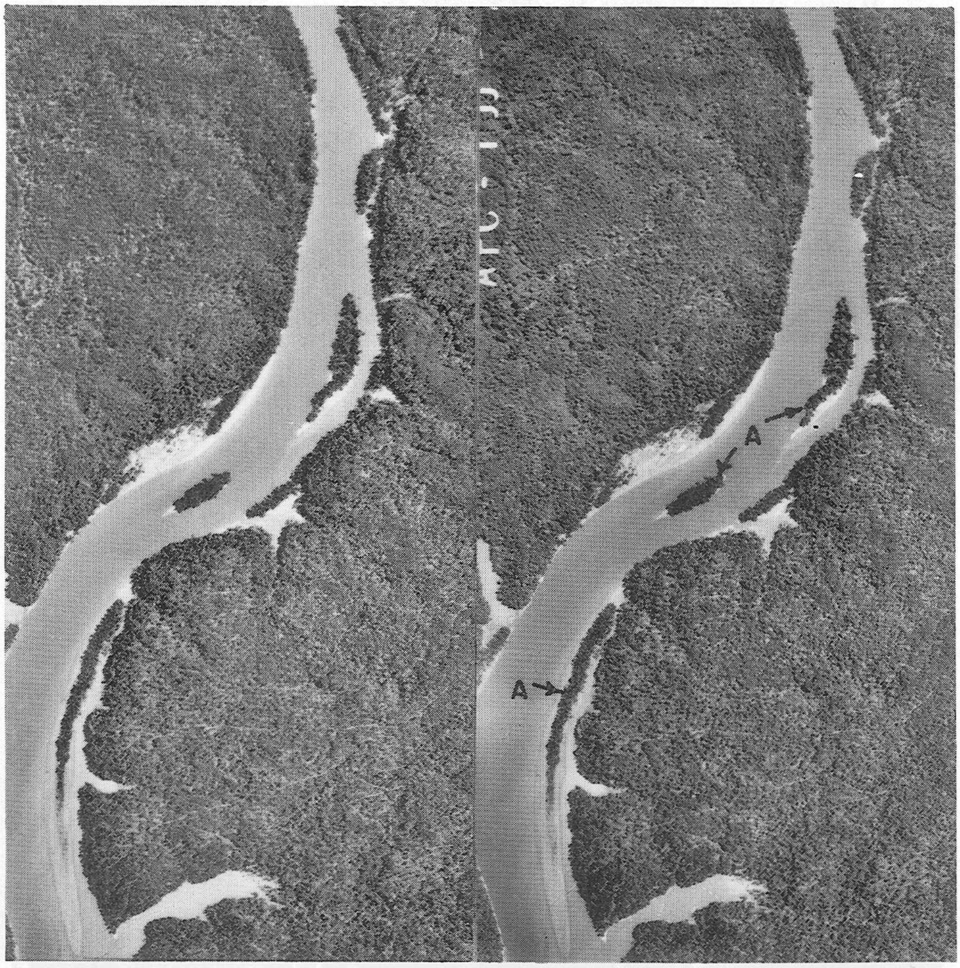

FIGURE 17. Stereogram showing stands of black willow (A) on sandbars (Tallapoosa County). (APC-1JJ-277,278)

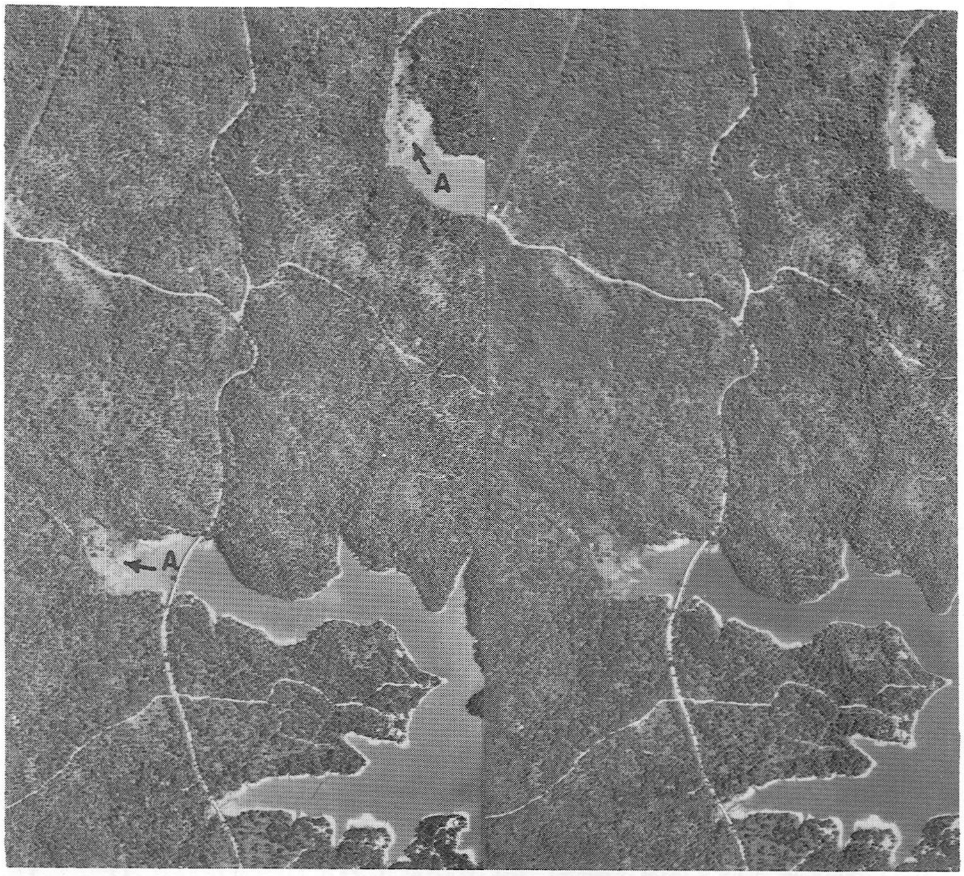

FIGURE 18. Stereogram showing stands of black willow (A) at mouths of streams. (Tallapoosa County). (APC-1JJ-283,284)

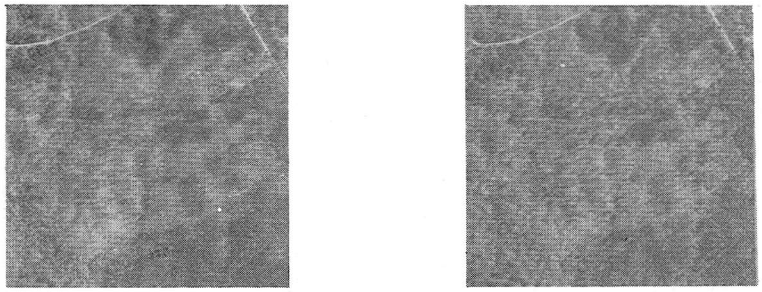

FIGURE 19. Stereogram with low contrast (Chambers County). (GS-2EE-77,78)

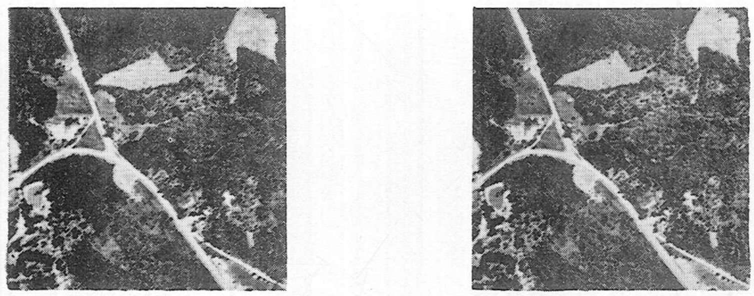

FIGURE 20. Stereogram with high contrast (Clay County). (GV-1JJ-181, 182)

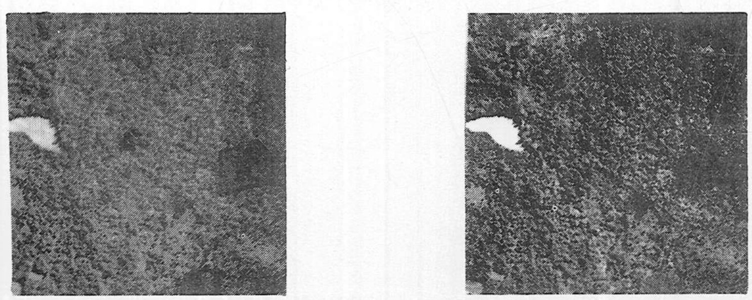

FIGURE 21. Stereogram showing hardwoods (A) and pine (B) during the fall color season (Clay County). (GV-1JJ-181,182)

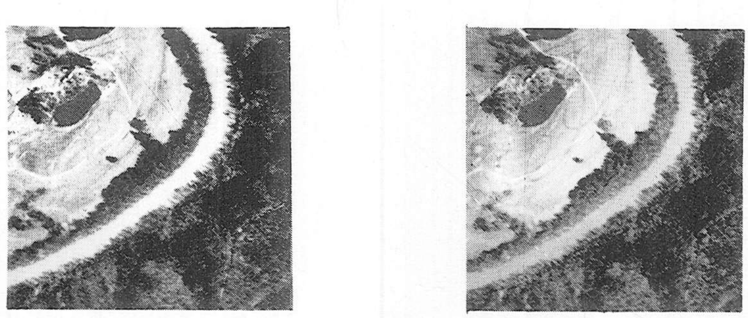

FIGURE 22. Stereogram showing shadows of hardwoods falling clear on the surface of a stream. The crown characteristics are quite clear. (Chambers County). (GS-3EE-34,35)

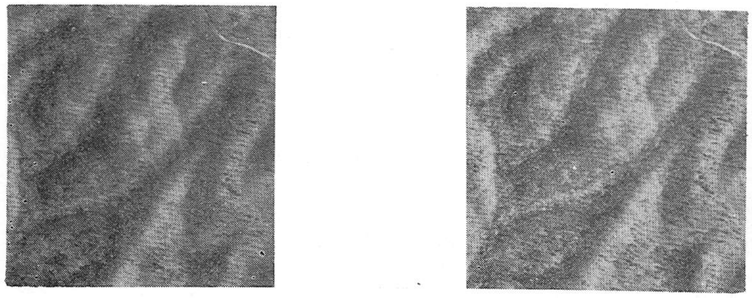

FIGURE 23. Stereogram showing shadows of hardwoods in a relatively dense stand. Note the striated appearance of the shadows. Density of the striations is correlated with stand density. (Randolph County) (HT-1EE-53, 54)

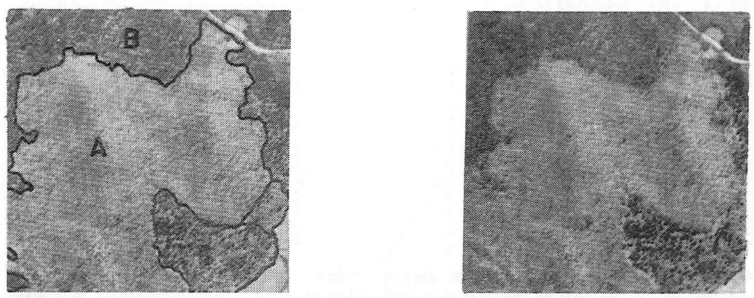

FIGURE 24. Stereogram showing the contrast between hardwoods (A) and pines (B) in early spring when the leaves are beginning to open. (Lee County) (ED-2EE-150,151)

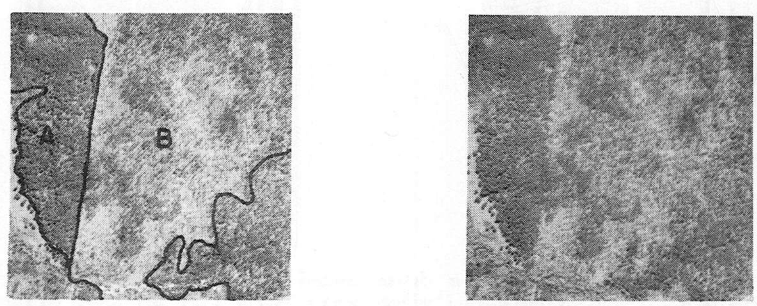

FIGURE 25. Stereogram of a dense stand of pine (A) adjacent to a stand of mixed pine and hardwoods (B). (Lee County) (ED-2EE-150,151)

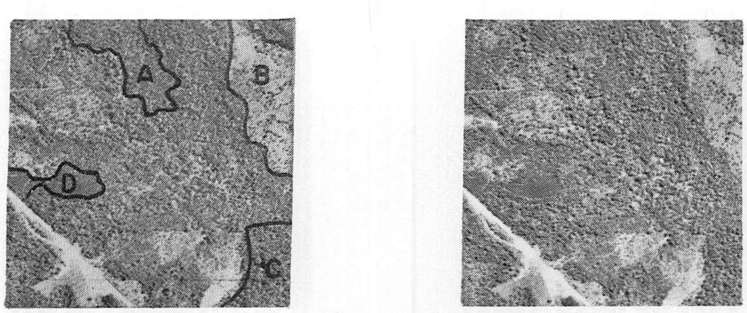

FIGURE 26. Stereogram of a medium dense stand of pine (A), a field restocking to pine (B), a dense stand of mixed pine and hardwoods (C), and a small, dense pine plantation (D). (Tallapoosa County) (APC-1JJ-211,212)

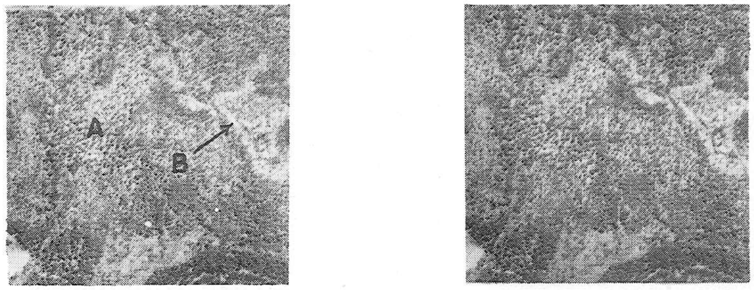

FIGURE 27. Stereogram of an open stand of pine (A), with light toned brush along the stream (B). (Lee County) (ED-2EE-150,151)

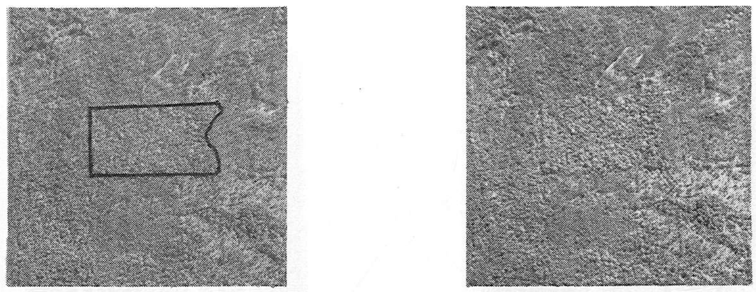

FIGURE 28. Stereogram of a dense mixed pine-hardwood stand. The photographs were taken during the fall color season. Discrimination between the pines and hardwoods would be on the basis of tones of grey. (Tallapoosa County) (APC-1JJ-36,37)

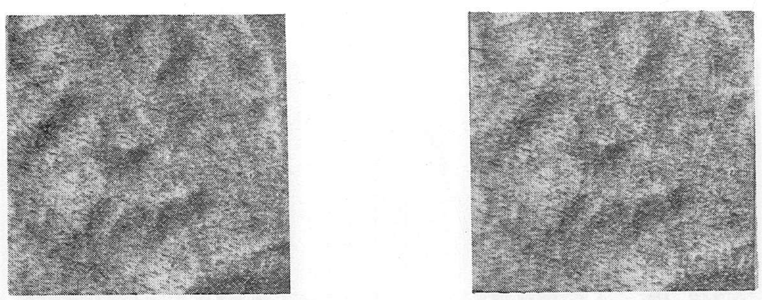

FIGURE 29. Stereogram of a dense mixed pine-hardwood stand. The photographs were taken during winter when leaves were off most of the hardwoods. The pine crowns are still full. The only evidence of the hardwoods is the shadow pattern and a few light-toned crowns still holding leaves. (Randolph County) (HT-1EE-163,164)

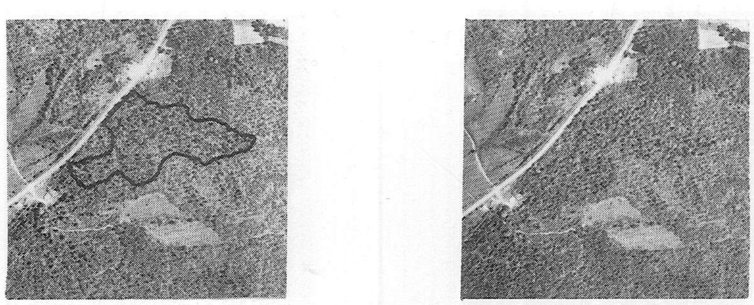

FIGURE 30. Stereogram of a two-storied, mixed pine-hardwood stand. The overstory is medium stocked. The photographs were taken during the fall color season. Discrimination between the pines and hardwoods would be on the basis of tones of grey. (Clay County) (GV-2JJ-100,101)

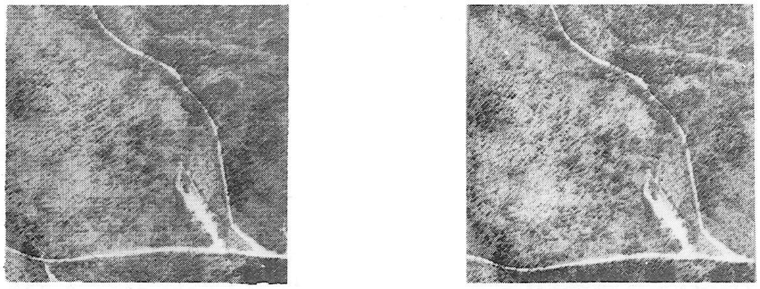

FIGURE 31. Stereogram of a medium stocked, mixed pine-hardwood stand. The photographs were taken in the spring before leaf development was complete. The hardwood component is revealed primarily by shadows. (Lee County) (ED-2EE-150,151)

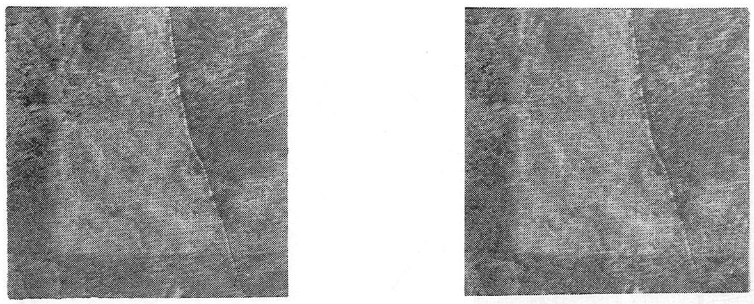

FIGURE 32. Stereogram of a cut-over area with a thin residual stand of mixed pines and hardwoods. The hardwood crowns are light toned while the pine crowns are dark toned. (Chambers County) (GS-2EE-77,78)

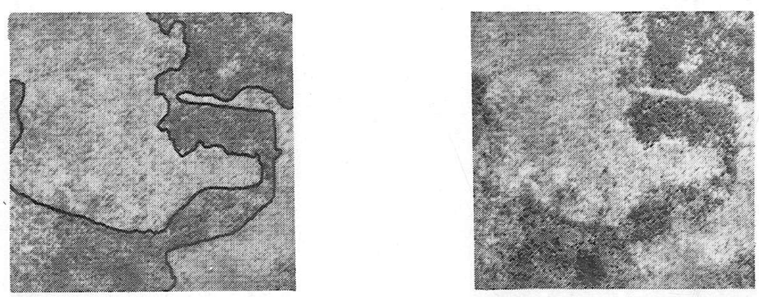

FIGURE 33. Stereogram of a thin stand of mixed pines and hardwoods. The hardwood component can be evaluated only by shadows. Though photographed in the spring, when the leaves were developing, the hardwood crowns are not distinct because the understory is also light-toned. (Lee County) (ED-2EE-150,151)

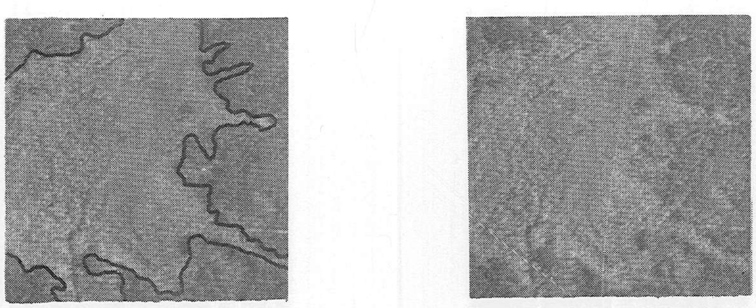

FIGURE 34. Stereogram of a dense stand of hardwoods. The photographs were taken in the winter and nearly all of the hardwood leaves have fallen. Although contrast level is low, the few remaining leaves cause the hardwood crowns to be distinctly lighter in tone than the pine crowns. (Chambers County) (GS-2EE-77,78)

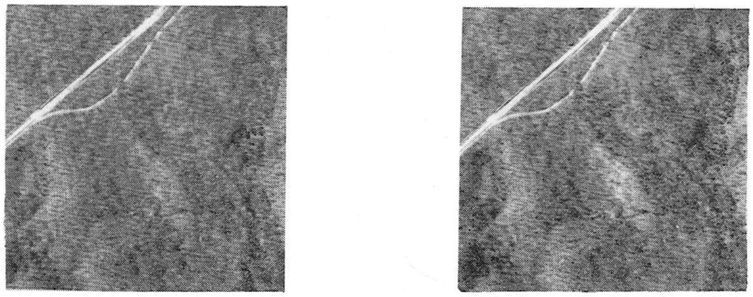

FIGURE 35. Stereogram of a dense stand of hardwoods. The photographs were taken in the winter when few of the hardwood crowns still bore leaves. Density of the stand must be judged from shadows. (Randolph County) (HT-2EE-213,214)

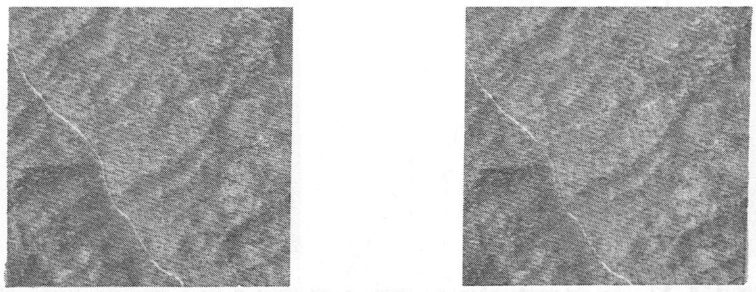

FIGURE 36. Stereogram of a patchy stand of hardwoods ranging from medium to high density. Though the photographs were taken in winter many of the hardwoods still bear leaves. Density of the stand must be judged jointly from the crowns and the shadows. (Chambers County) (GS-3EE-34,35)

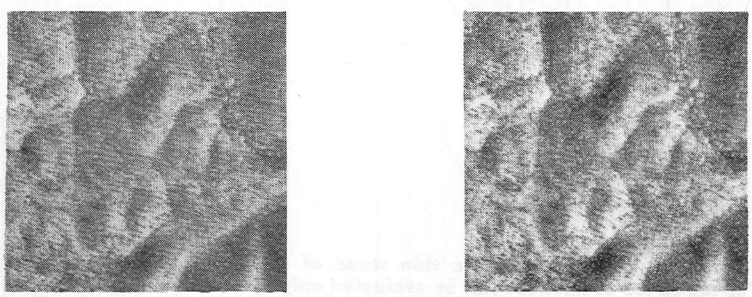

FIGURE 37. Stereogram of a medium dense hardwood stand. The density must be judged primarily from shadows. (Randolph County) (HT-1EE-55,56)

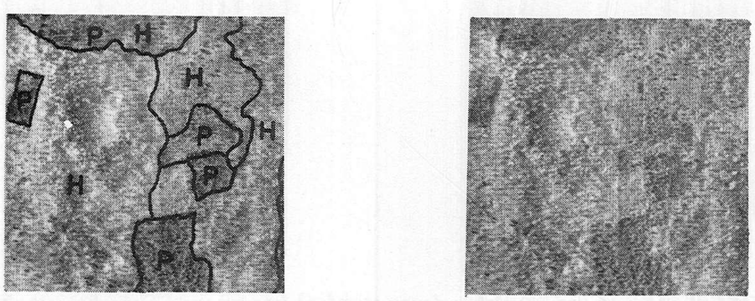

FIGURE 38. Stereogram showing a variety of hardwood and pine stands. The photographs were taken in the winter, but many of the hardwoods still retain their leaves. Stand density must be judged from tones of crowns and shadow patterns. (Randolph County) (HT-2EE-213,214)

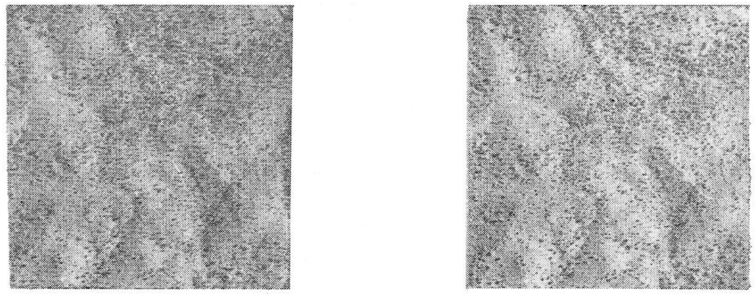

FIGURE 39. Stereogram of a thin stand of hardwoods in the fall color season. The hardwood crowns are visible and can be used to determine relative density of the hardwood component. (Clay County) (GV-2JJ-100, 101)

FIGURE 40. Stereogram showing a hardwood stand of medium to low density (A). The pine component of this stand is less than 30 percent of the stand basal area. In stand B, the density remains medium to low, but the pine component is sufficiently large for the stand to be classed as pine-hardwood. Relative density of the hardwood component can be determined from the shadow pattern. (Lee County) (ED-2EE-150,151)

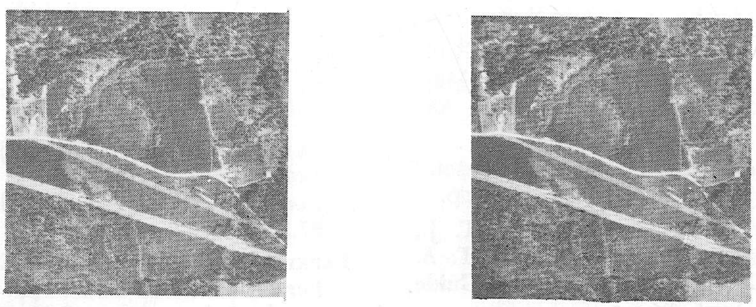

FIGURE 41. Stereogram showing several young pine plantations. The rows of trees are readily visible. (Chambers County) (GS-3EE-34,35)

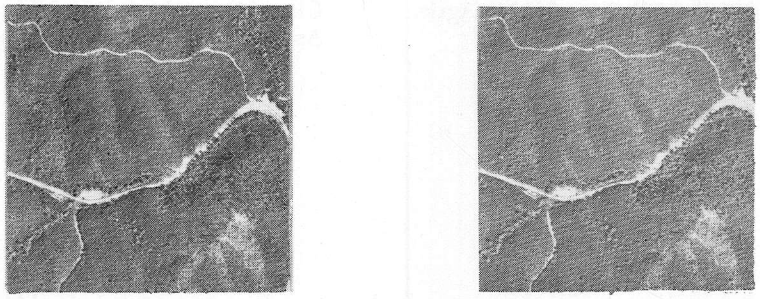

FIGURE 42. Stereogram of an extensive pine plantation that is older than the plantations shown in 41. Rows can be detected but they are not obvious. The extreme uniformity of the stand indicates its non-natural origin. (Coosa County) (DKB-1JJ-249,250)

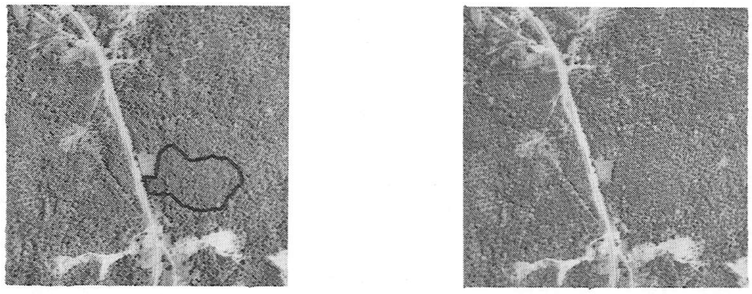

FIGURE 43. Stereogram of a pine plantation that is older than the one shown in 42. The rows become less evident as the plantation grows older. (Tallapoosa County) (APC-1JJ-211,212)

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APPENDIX I

Forest Cover Photo-Interpretation Key for the Piedmont Forest Habitat Region in Alabama

1. Stand highly uniform with regard to density, tree heights, crown widths, and tone. Photographic tone[1] is dark grey. Rows may or may not be visible. May be on any site (Figures 41, 42, and 43) ---- Pine plantation[2]
1. Stand is not as above ---- 2
   2. Stand is on an upland site (Figure 10) ---- 3
   2. Stand is on a streambottom site ---- 33
3. Stand is in the Devil's Backbone area (Figures 1, 58, and 62) ---- 4
3. Stand is not in the Devil's Backbone area ---- 6
   4. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 44 A
   4. Tree crowns are not as above ---- 5
5. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 44 B
5. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) ---- 44 C
   6. Stand is on a peneplane hill (Figures 3, 4, 5, 6, 11, 12, and 13) ---- 7
   6. Stand is on a monadnock (Figures 7, 8, 9, and 54 through 62) ---- 31
7. Hill has a broad crest, 250 feet or wider or 0.15 inches on photographs at a scale of 1:20,000 (Figure 11) ---- 8
7. Hill has a narrow crest, less than 250 feet wide or 0.15 inches on photographs at a scale of 1:20,000 (Figure 12) ---- 19
   8. Side slopes of hill are gentle, from 0 to 15 percent (Figure 5) ---- 9
   8. Side slopes of hill are steeper than 15 percent (Figure 6) ---- 14
9. Stand is on the Opelika Plateau (Figures 1, 56, 57, 58, and 62) ---- 10
9. Stand is on the Ashland Plateau (Figures 1, 56, 57, 58, and 62) ---- 12
   10. 70 percent or more of the overstory tree crowns are dark grey (Figure 25, 26, and 27) ---- 45 A
   10. Tree crowns not as above ---- 11
11. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 45 B
11. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) ---- 45 C
   12. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 46 A
   12. Tree crowns are not as above ---- 13
13. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 46 B
13. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) ---- 46 C
   14. Stand is on the Opelika Plateau (Figures 1, 56, 57, 58, and 62) ---- 15
   14. Stand is on the Ashland Plateau (Figures 1, 57, 58, and 62) ---- 17
15. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 47 A
15. Tree crowns are not as above ---- 16
   16. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 47 B
   16. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 70) ---- 47 C
17. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 48 A
17. Tree crowns are not as above ---- 18
   18. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 48 B
   18. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 70) ---- 48 C
19. Hill is small, covering an area of less than 50 acres (at a scale of 1:20,000, a circle with a diameter of 1 inch covers 50 acres and a rectangle 1 inch long and ¾ inch wide covers 48 acres) (see hills labeled B in Figure 12) ---- 8[3]
19. Hill is larger than 50 acres ---- 20
   20. Side slopes of hills are gentle, from 0 to 15 percent (Figure 5) ---- 21
   20. Side slopes of hill are steeper than 15 percent (Figure 6) ---- 26
21. Stand is on the Opelika Plateau (Figures 1, 56, 57, 58, and 62) ---- 22
21. Stand is on the Ashland Plateau (Figures 1, 56, 57, 58, and 62) ---- 24
   22. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 49 A
   22. Tree crowns are not as above ---- 23
23. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 49 B
23. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) ---- 49 C
   24. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 50 A
   24. Tree crowns are not as above ---- 25
25. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 50 B
25. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) ---- 50 C
   26. Stand is on the Opelika Plateau (Figures 1, 56, 57, 58, and 62) ---- 27
   26. Stand is on the Ashland Plateau (Figures 1, 56, 57, 58, and 62) ---- 29
27. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 51 A
27. Tree crowns not as above ---- 28
   28. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 51 B
   28. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) ---- 51 C
29. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) ---- 52 A
29. Tree crowns are not as above ---- 30
   30. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) ---- 52 B

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[1] References to photographic tone are applicable to photographs taken on panchromatic film through a deep yellow (e.g., Wratten No. 12) filter. They may also be applicable to photographs taken on black and white infrared film through a deep yellow (e.g., Wratten No. 12) or deep red (e.g., Wratten No. 89B) filter.

[2] Pine plantations in the Piedmont are mainly loblolly pine, but longleaf pine has been planted sporadically in the Ashland Plateau. Because site has not been an appreciable factor in the choice of species to plant, it is difficult or impossible to recognize the species in a given plantation.

[3] This is no mistake. Small hills, regardless of their crest width, have vegetation patterns similar to broad crested hills. Hence the folding back of the key on itself.

30. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) .... 52 C
31. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) .... 53 A
31. Tree crowns are not as above 32
32. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) .... 53 B
32. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) .... 53 C
33. Stream is at or immediately below headwaters area (Figures 3 or 9) 34
33. Stream is second order or higher, below headwaters area (Figures 3 or 9) 42
34. Headwaters area is cup-shaped or a deep ravine (cove, Figure 14) 35
34. Headwaters is area not cup-shaped or a deep ravine 37
35. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) .... P(4)
35. Tree crowns are not as above 36
36. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) .... PH(4)
36. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) .... H(3)
37. Stand is in the Devil's Backbone area (Figures 1, 58, and 62) 38
37. Stand is not in the Devil's Backbone area 40
38. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) .... P(3)
38. Tree crowns are not as above 39
39. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) .... PH(5)
39. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) .... H(4)
40. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) .... P(3)
40. Tree crowns are not as above 41
41. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) .... PH(3)
41. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) .... H(4)
42. Stand on streambottom, immediately adjacent to stream. Stand may or may not have an overstory. If it has an overstory this description refers only to the *understory.* Go to 43 for the overstory. Stand is very dense. It is made up of trees or shrubs that are less than 20 feet in height. The photographic tone is light grey .... H(8)
42. Stand is not as above 43
43. Stand is at mouth of stream where it enters lake or pond. The photographic tone is dark grey (Figure 18) .... H(7)
43. Stand is not as above 44
44. Stream proper is less than 30 feet in width or less than 0.02 inches on photographs at a scale of 1:20,000 (Figures 3, 4, and 9) 45
44. Stream proper is 30 feet or wider or more than 0.02 inches on photographs at a scale of 1:20,000 (Figures 4, 15, and 16) 47
45. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) .... P(3)
45. Tree crowns are not as above 46
46. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) .... PH(3)
46. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) H(5)
47. Stand on sand bars in or on edge of stream. 70 percent or more of the overstory tree crowns are dark grey .... H(7)
47. Stand not on sand bars 48
48. 70 percent or more of the overstory tree crowns are dark grey (Figures 25, 26, and 27) .... P(3)
48. Tree crowns are not as above 49
49. 30 to 70 percent of the overstory tree crowns are dark grey (Figures 28 through 33) .... PH(3)
49. Less than 30 percent of the overstory tree crowns are dark grey (Figures 34 through 40) .... H(6)

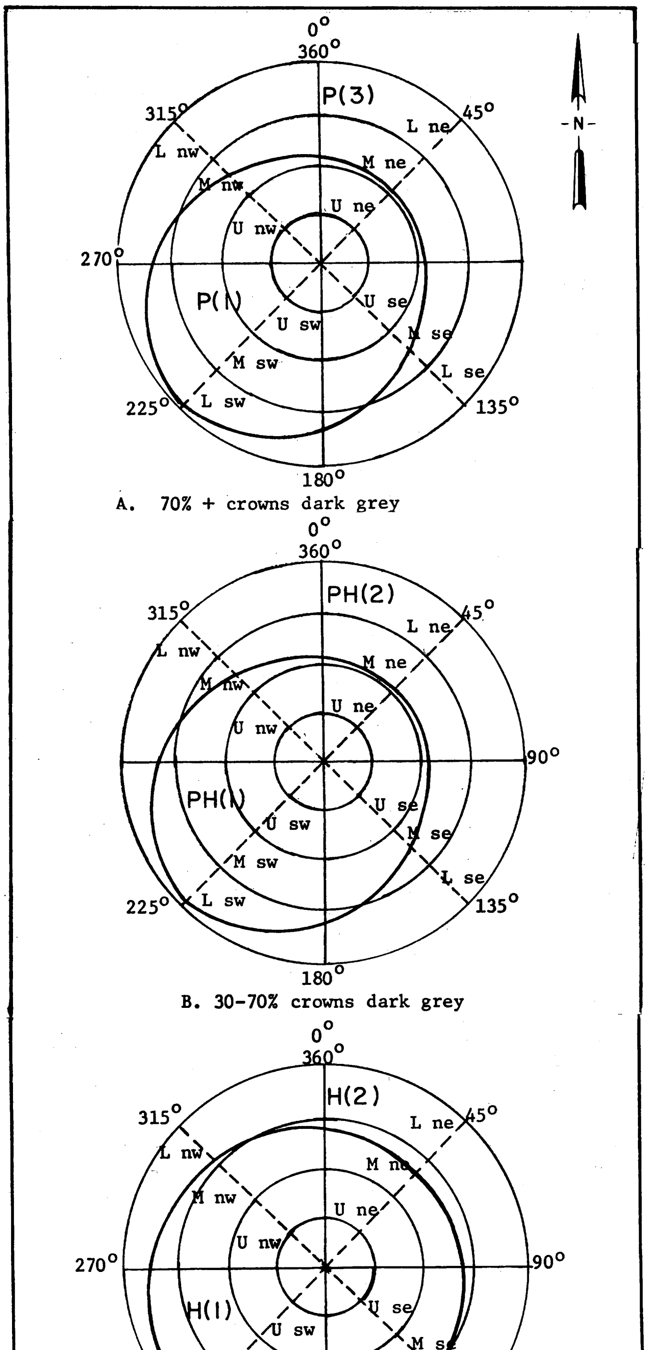


FIGURE 44. Forest cover type distribution in the Devil's Backbone. Because of the narrowness of most of the ravines in this area, the base level is higher on the slope than is common elsewhere. It also must be emphasized that each spur ridge must be considered as a separate hill. Transition zones where spur ridges join main ridges probably should be considered as belonging to the slope position on the main ridge at the point of juncture. Most saddles appear to take on the characteristics of midslopes. In the portions of the Devil's Backbone inundated by Lake Martin the base level will be under water and slope position will have to be estimated.

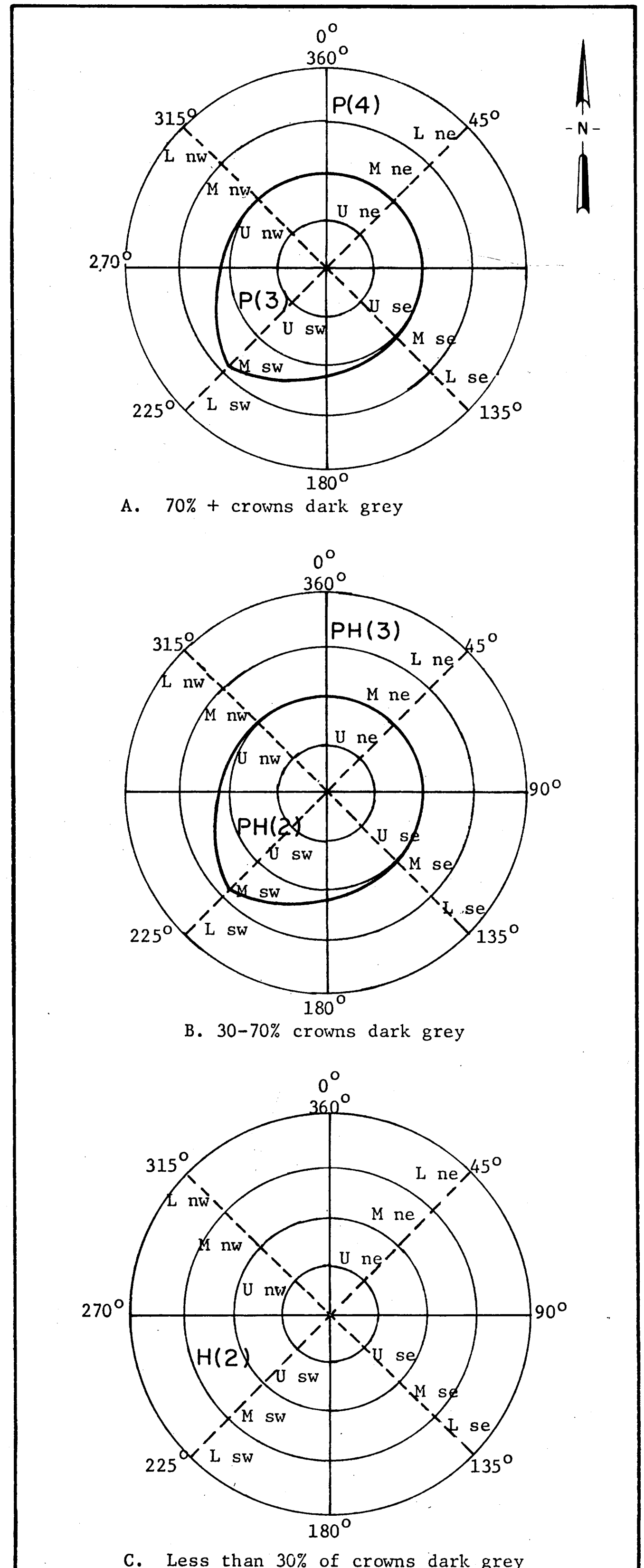


FIGURE 45. Forest cover type distribution on broad crested peneplane hills, with gentle side slopes, in the Opelika Plateau. These diagrams also are appropriate for small peneplane hills with narrow crests and gentle side slopes. Each spur ridge must be considered as a separate hill.

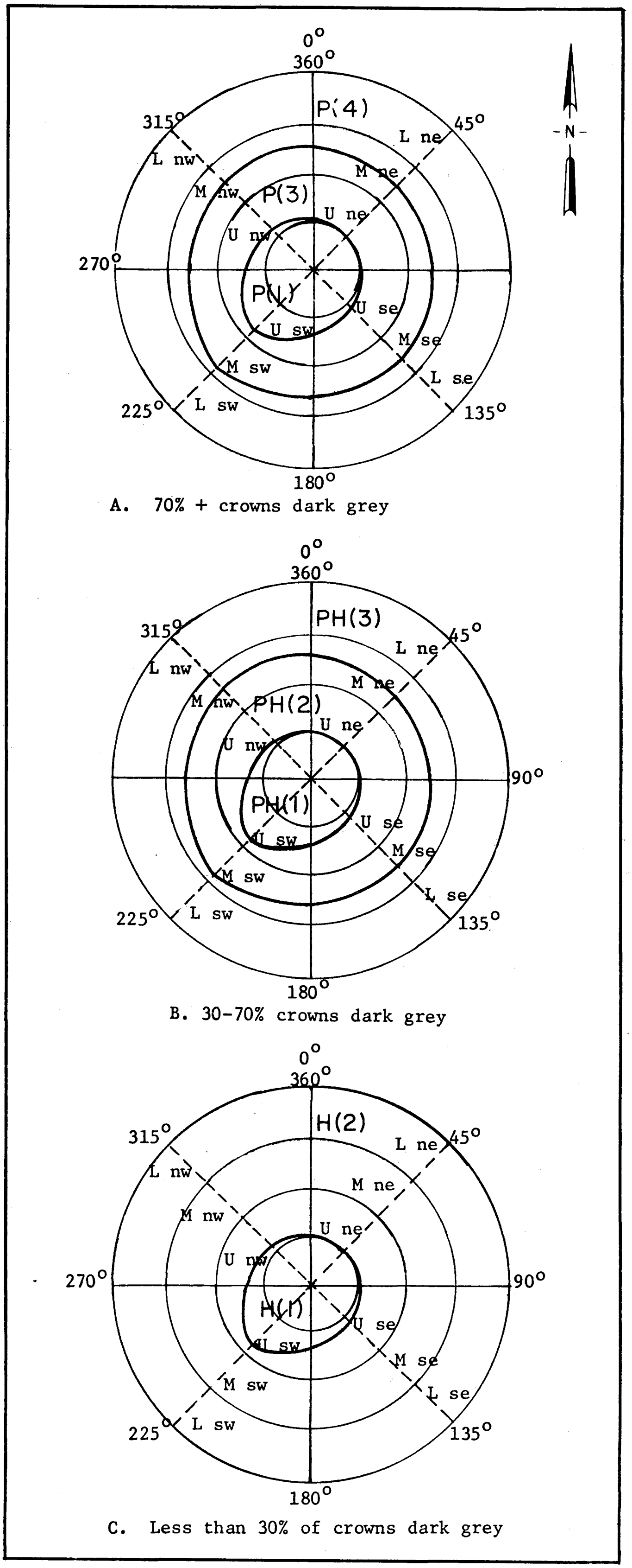


FIGURE 46. Forest cover type distribution on broad crested peneplane hills, with gentle side slopes, in the Ashland Plateau. These diagrams also are appropriate for small peneplane hills with narrow crests and gentle side slopes. Each spur ridge must be considered as a separate hill.

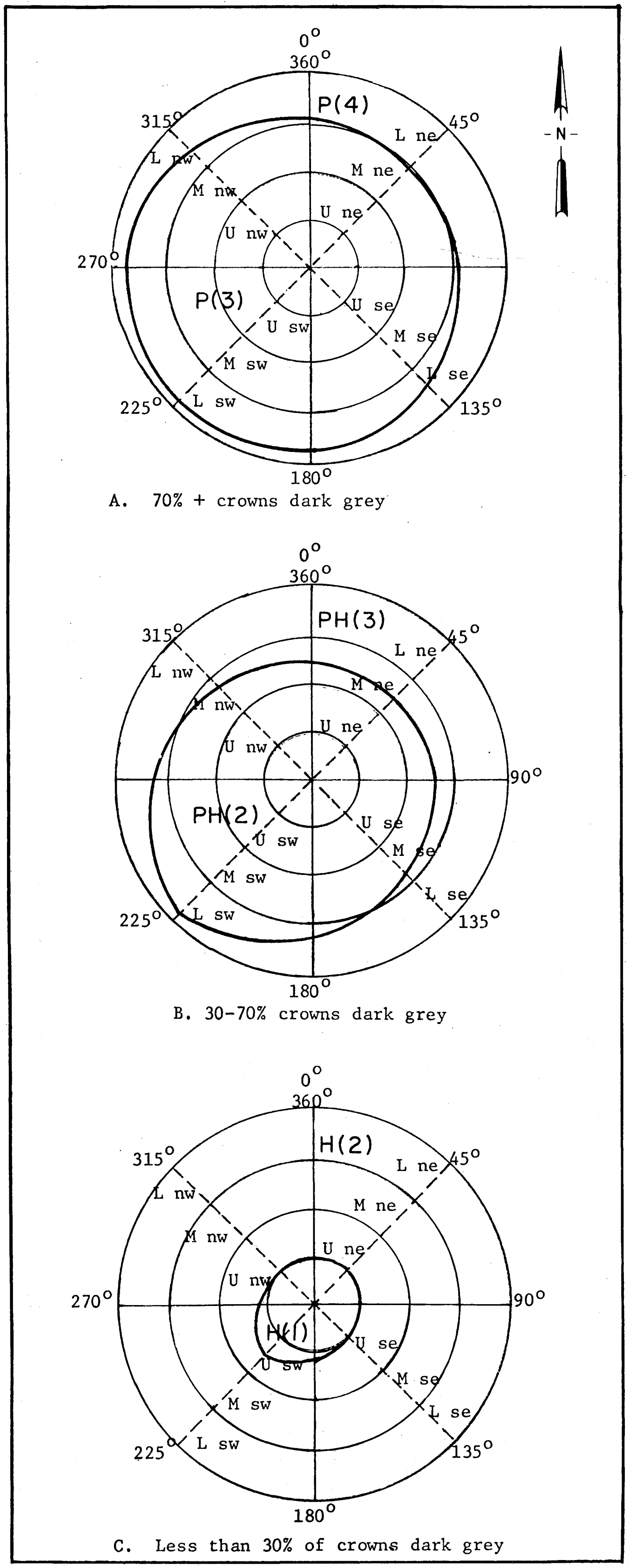
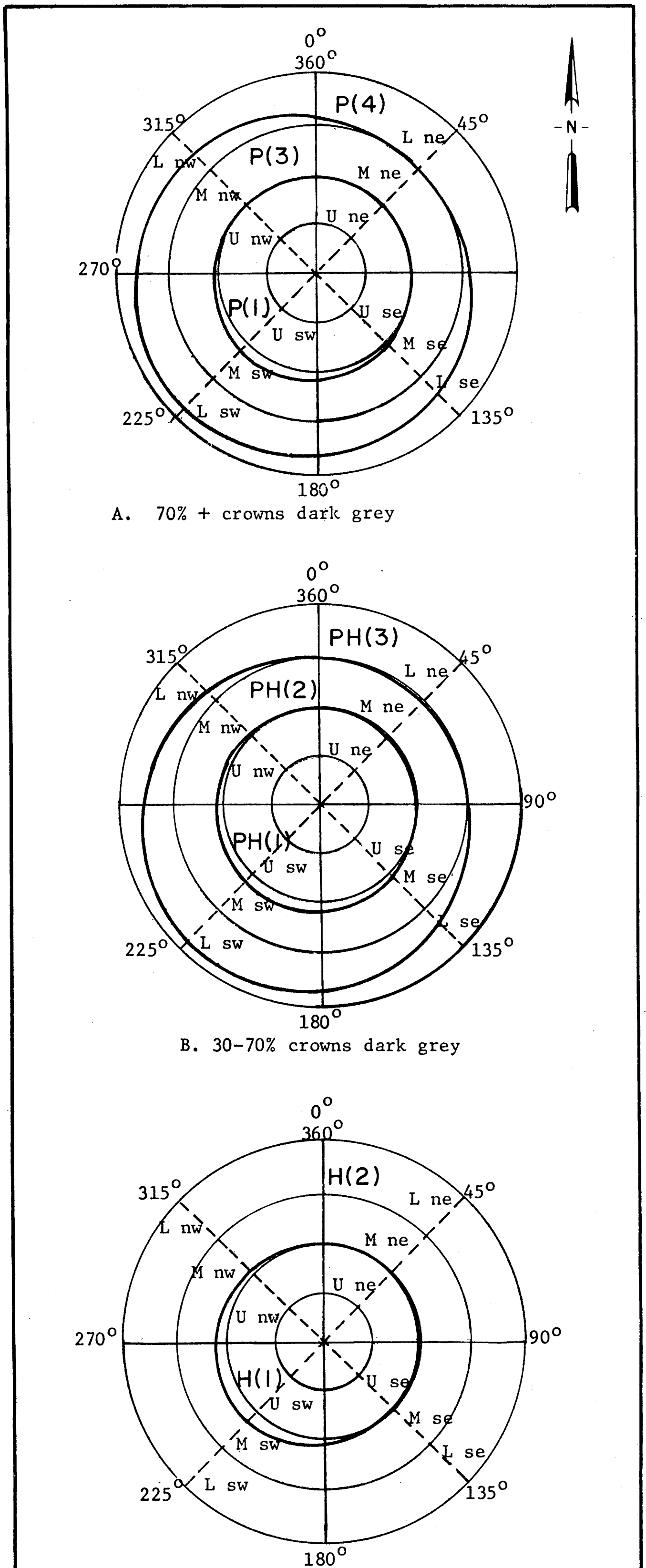


FIGURE 47. Forest cover type distribution on broad crested peneplane hills, with steep side slopes, in the Opelika Plateau. These diagrams also are appropriate for small peneplane hills with narrow crests and steep side slopes. Each spur ridge must be considered as a separate hill.

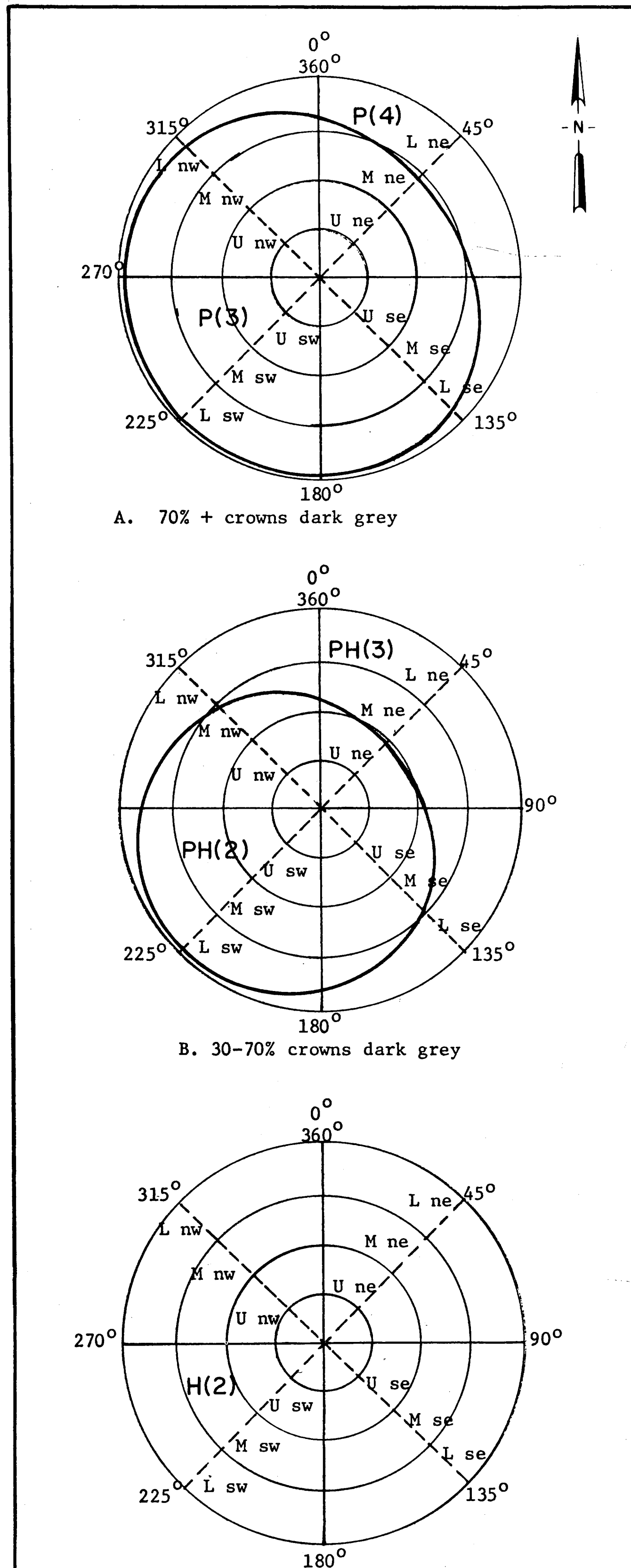


A. 70% + crowns dark grey

B. 30-70% crowns dark grey

C. Less than 30% of crowns dark grey

FIGURE 48. Forest cover type distribution on broad crested peneplane hills, with steep side slopes, in the Ashland Plateau. These diagrams also are appropriate for small peneplane hills with narrow crests and steep side slopes. Each spur ridge must be considered as a separate hill.

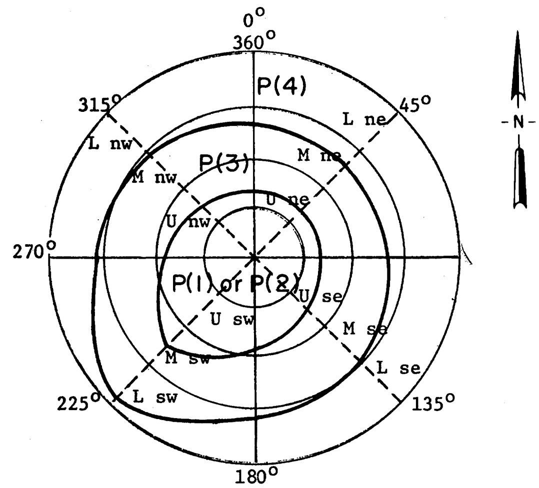


A. 70% + crowns dark grey

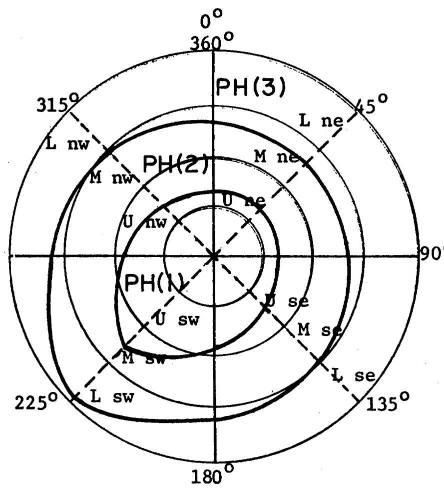
B. 30-70% crowns dark grey

C. Less than 30% of crowns dark grey

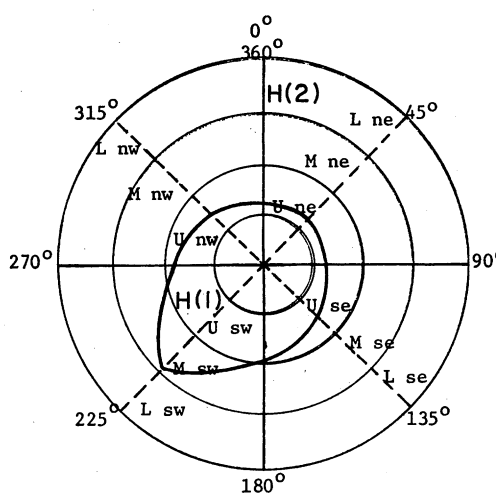
FIGURE 49. Forest cover type distribution on large narrow crested peneplane hills, with gentle side slopes, in the Opelika Plateau. Each spur ridge must be considered as a separate hill.



A. 70% + crowns dark grey

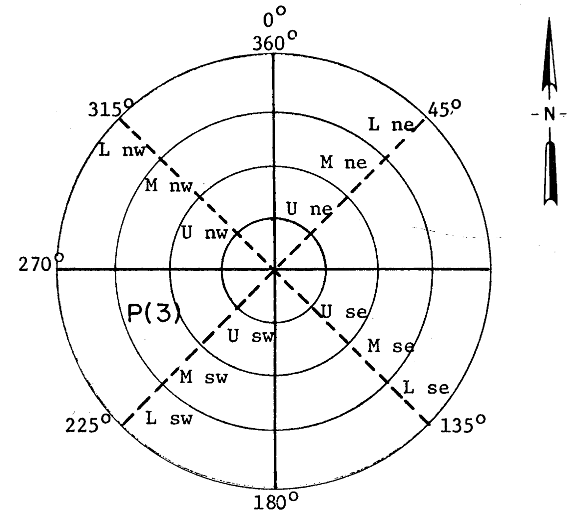


B. 30-70% crowns dark grey

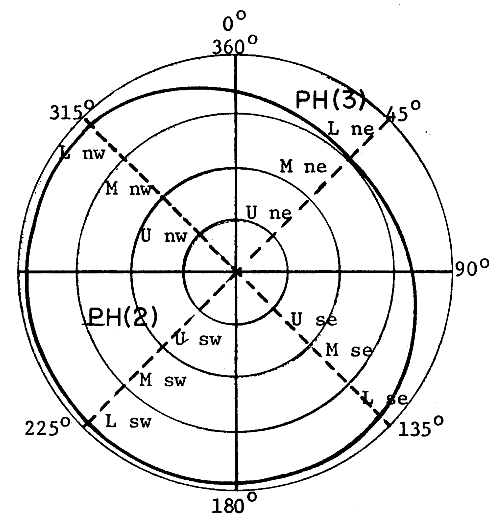


C. Less than 30% of crowns dark grey

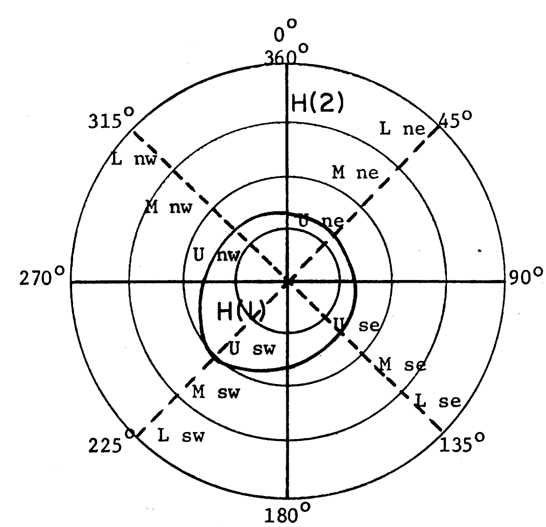
FIGURE 50. Forest cover type distribution on large narrow crested peneplane hills, with gentle side slopes, in the Ashland Plateau. Each spur ridge must be considered as a separate hill. At high elevations in the northwestern portion of the Ashland Plateau (see Appendix V) the longleaf pine (P(1)) may be replaced by Virginia pine.



A. 70% + crowns dark grey

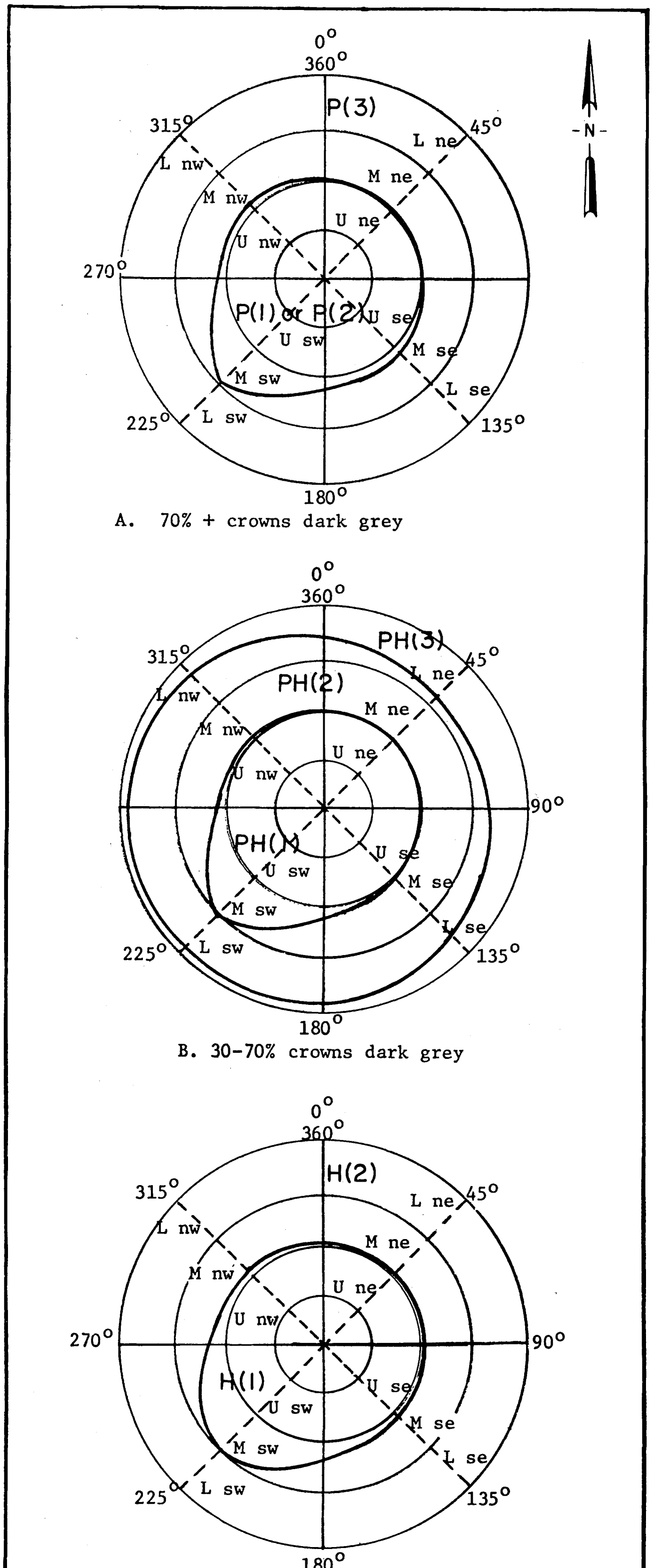


B. 30-70% crowns dark grey



C. Less than 30% of crowns dark grey

FIGURE 51. Forest cover type distribution on large narrow crested peneplane hills, with steep side slopes, in the Opelika Plateau. Each spur ridge must be considered as a separate hill.

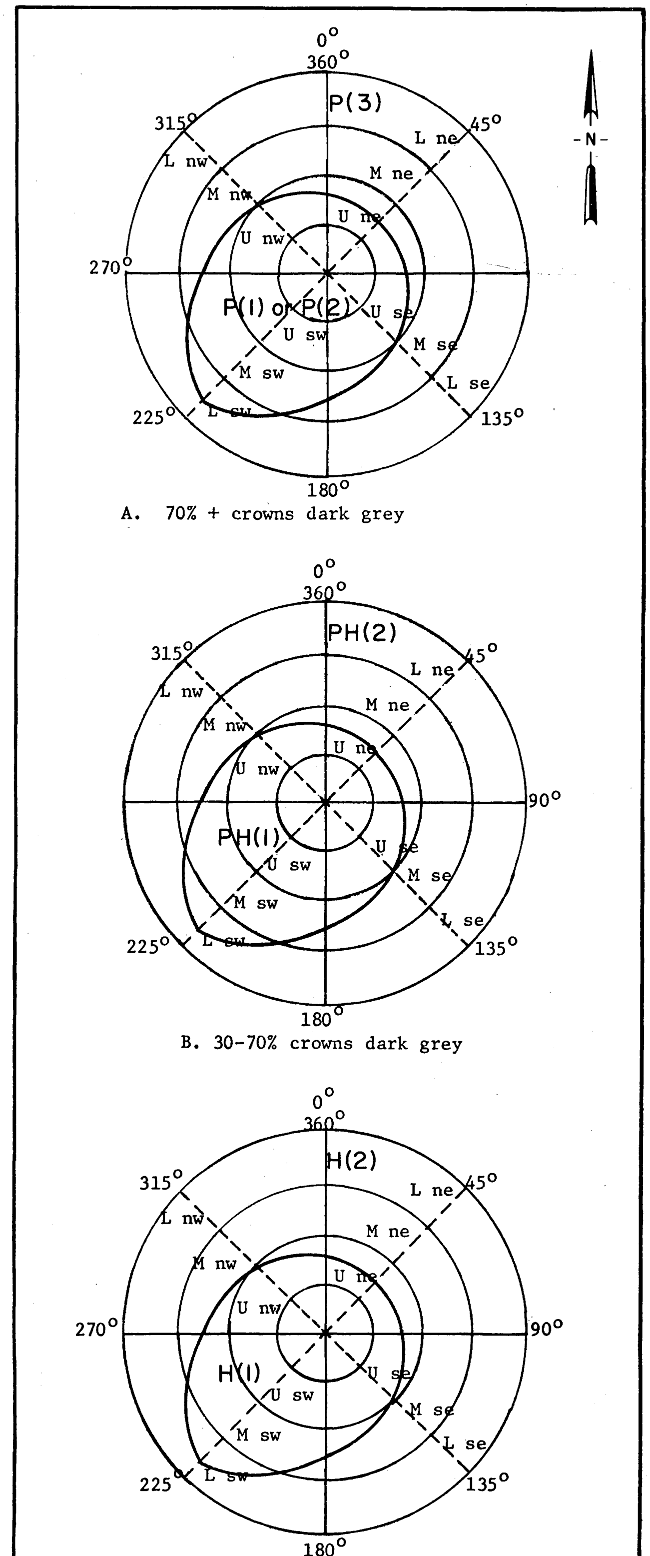


A. 70% + crowns dark grey

B. 30-70% crowns dark grey

C. Less than 30% of crowns dark grey

FIGURE 52. Forest cover type distribution on large narrow crested peneplane hills, with steep side slopes, in the Ashland Plateau. Each spur ridge must be considered as a separate hill. At high elevations in the northwestern portion of the Ashland Plateau (see Appendix V) the longleaf pine (P(1)) may be replaced by Virginia pine.



A. 70% + crowns dark grey

B. 30-70% crowns dark grey

C. Less than 30% of crowns dark grey

FIGURE 53. Forest cover type distribution on monadnocks. It must be emphasized that each spur ridge must be considered as a separate hill. Transition zones where spur ridges join main ridges probably should be considered as belonging to the slope position on the main ridge at the point of juncture. Most saddles appear to take on the characteristics of midslopes. At high elevations in the northwestern portion of the Ashland Plateau (see Appendix V) the longleaf pine (P(1)) may be replaced by Virginia pine.

APPENDIX II

Forest Cover Types Occurring in the Piedmont in Alabama

Cover Type	Symbol	Approx. S.A.F. Equivalents[1,2]	Description[3]
Longleaf pine	P(1)	70	Longleaf pine makes up 70 percent or more of the stand basal area. Common associates are shortleaf pine, blackjack oak, post oak, southern red oak, pignut hickory, and mockernut hickory. Occasional associates include loblolly pine, Virginia pine, sweetgum, yellowpoplar, and black tupelo.
Virginia pine	P(2)	79	Virginia pine makes up 70 percent or more of the stand basal area. Common associates are longleaf pine, shortleaf pine, blackjack oak, post oak, chestnut oak, pignut hickory, and mockernut hickory. Occasional associates include loblolly pine, sweetgum, and black tupelo.
Shortleaf pine	P(3)	75,80	Shortleaf and loblolly pines make up 70 percent or more of the stand basal area, with shortleaf being predominant. A common associate is sweetgum. Occasional associates include southern red oak, post oak, blackjack oak, scarlet oak, chestnut oak, white oak, yellowpoplar, black tupelo, longleaf pine, and Virginia pine.
Loblolly pine	P(4)	81	Loblolly and shortleaf pine make up 70 percent or more of the stand basal area, with loblolly being predominent. Common associates are white oak, yellowpoplar, and sweetgum. Occasional associates include water oak, American beech, red maple, northern red oak, southern red oak, and pignut hickory.
Longleaf pine-hardwoods	PH(1)	71	Longleaf pine, mockernut hickory, pignut hickory, southern red oak, blackjack oak, or post oak, in any combination, make up 70 percent or more of the stand basal area. The pine component makes up no less than 30 percent nor more than 70 percent of the stand basal area. A common associate is shortleaf pine. Occasional associates include loblolly pine, sweetgum, yellowpoplar, northern red oak, white oak, and chestnut oak.
Pine-hardwoods intermediate	PH(2)	76	Shortleaf pine, loblolly pine, longleaf pine, mockernut hickory, pignut hickory, blackjack oak, southern red oak, northern red oak, chestnut oak, and sweetgum, in any combination, make up 70 percent or more of the stand basal area. Usually shortleaf is the predominant pine. The pine component makes up no less than 30 percent nor more than 70 percent of the stand basal area. Common associates are post oak and white oak. Occasional associates include scarlet oak, black tupelo, black cherry, and yellowpoplar.
Pine-hardwoods, moist	PH(3)	82	Loblolly pine, shortleaf pine, yellowpoplar, sweetgum, and red maple, in any combination, make up 70 percent or more of the stand basal area. Usually loblolly is the predominant pine. The pine component makes up no less than 30 percent nor more than 70 percent of the stand basal area. Common associates are southern red oak and water oak. Occasional associates include winged elm, boxelder, mulberry, American beech, black cherry, northern red oak, pignut hickory, bitternut hickory, hazel alder, and eastern red cedar.
Pine-hardwoods, cove	PH(4)	82	Loblolly pine, yellowpoplar, sweetgum, American beech, red maple, and white oak, in any combination make up 70 percent or more of the stand basal area. The pine component makes up no less than 30 percent nor more than 70 percent of the stand basal area. Common associates are northern red oak, southern red oak, and water oak. Occasional associates include black cherry, bitternut hickory, and winged elm.

[1] Anon., 1964.
[2] The S.A.F. cover types listed are only approximations of the ones described and used in this study. In some cases the differences are substantial. One should not consider the two classes of cover types to be alike except in a very general sense.
[3] See Appendix III for the scientific names of the species mentioned.

Pine-hardwoods, headwaters	PH(5)	----	Longleaf pine, shortleaf pine, loblolly pine, yellowpoplar, sweetgum, white oak, chestnut oak, northern red oak, southern red oak, or pignut hickory, in any combination, make up 70 percent or more of the stand basal area. Usually longleaf is the predominant pine. The pine component makes up no less than 30 percent nor more than 70 percent of the stand basal area. Occasional associates include red maple, black cherry, and post oak.
Upland hardwoods, dry	H(1)	40,72	Blackjack oak, post oak, mockernut hickory, pignut hickory, scarlet oak, or southern red oak, in any combination, make up 70 percent or more of the stand basal area. Blackjack oak and/or post oak are almost always present. Common associates are longleaf pine, shortleaf pine, chestnut oak (in the Ashland Plateau and the Devil's Backbone), and northern red oak. Occasional associates include loblolly pine, white oak, black tupelo, and sweetgum.
Upland hardwoods, intermediate	H(2)	52,53	White oak, northern red oak, sweetgum, mockernut hickory, pignut hickory, southern red oak, scarlet oak, post oak, or chestnut oak (in the Ashland Plateau and the Devil's Backbone), in any combination, make up 70 percent or more of the stand basal area. Many species may occur as occasional associates. Among these may be yellowpoplar, American beech, water oak, black tupelo, black cherry, basswood, shortleaf pine, and loblolly pine.
Cove hardwoods	H(3)	57,58	Yellowpoplar, American beech, sweetgum, water oak, white oak, black cherry, or chestnut oak (in the Ashland Plateau), in any combination, make up 70 percent or more of the stand basal area. Common associates are red maple, black tupelo, southern red oak, northern red oak, and loblolly pine. Occasional associates include white ash, green ash, sweetbay, pignut hickory, bitternut hickory, and basswood.
Headwaters hardwoods	H(4)	57,82,87	Yellowpoplar, white oak, northern red oak, southern red oak, pignut hickory, sweetgum, or American beech, in any combination, make up 70 percent or more of the stand basal area. Common associates are loblolly pine, red maple, and bitternut hickory. Occasional associates include chestnut oak, basswood, black cherry, sweetbay, and post oak.
Branch hardwoods	H(5)	57,87	Yellowpoplar, sweetgum, white oak, northern red oak, southern red oak, water oak, American beech, red maple, white ash, or green ash, in any combination, mak up 60 percent or more of the stand basal area. Common associates are loblolly pine, sweetbay, bitternut hickory, black tupelo, river birch, American elm, winged elm, hackberry, and hazel alder. Occasional associates include cherrybark oak, post oak, black cherry, mockernut hickory, pignut hickory, black walnut, black willow, sycamore, honey locust, eastern red cedar, and shortleaf pine.
Floodplain hardwoods	H(6)	61	River birch, white ash, green ash, sweetgum, yellowpoplar, sycamore, water oak, or black willow, in any combination, make up 70 percent or more of the stand basal area. Common associates are red maple, boxelder, hazel alder, black walnut, willow oak, mulberry, American hornbeam, and eastern cottonwood. Occasional associates include loblolly pine, white oak, American beech, sweetbay, winged elm, American elm, basswood, and bitternut hickory.
Black willow	H(7)	95	Black willow makes up 70 percent or more of the stand basal area. Common associates are eastern cottonwood and river birch.
Hazel alder	H(8)	----	Hazel alder makes up 70 percent or more of the stand basal area. Often occurs as the understory in two-storied stands where H(6) or H(7) form the overstory.

APPENDIX III

Scientific Names of Tree Species Mentioned in Report[1]

Conifers

Pines
- Loblolly pine .... *Pinus taeda* L.
- Longleaf pine .... *Pinus palustris* Mill.
- Shortleaf pine .... *Pinus echinata* Mill.
- Virginia pine .... *Pinus virginiana* Mill.

Junipers
- Eastern redcedar .... *Juniperus virginiana* L.

Broad-leaved Trees

Willows
- Black willow .... *Salix nigra* Marsh.

Poplars
- Eastern cottonwood .... *Populus deltoides* Marsh.

Walnuts
- Black walnut .... *Juglans nigra* L.

Hickories
- Mockernut hickory .... *Carya tomentosa* Nutt.
- Pignut hickory .... *Carya glabra* (Mill.) Sweet
- Bitternut hickory .... *Carya cordiformis* (Wangenh.) K. Koch.

Birches
- River birch .... *Betula nigra* L.
- Hazel alder .... *Alnus serrulata* (Aiton) Wild.[2]

Hornbeams
- American hornbeam .... *Carpinus caroliniana* Walt.

Beeches
- American beech .... *Fagus grandifolia* Ehrh.

Oaks
- Post oak .... *Quercus stellata* Wangenh.
- White oak .... *Quercus alba* L.
- Chestnut oak .... *Quercus prinus* L.
- Southern red oak .... *Quercus falcata* Michx.
- Cherrybark oak .... *Quercus falcata* var. *pagodaefolia* Ell.
- Northern red oak .... *Quercus rubra* L.
- Scarlet oak .... *Quercus coccinea* Muench.
- Willow oak .... *Quercus phellos* L.
- Blackjack oak .... *Quercus marilandica* Muench.
- Water oak .... *Quercus nigra* L.

Elms
- American elm .... *Ulmus americana* L.
- Winged elm .... *Ulmus alata* Michx.

Hackberries
- Common hackberry .... *Celtis occidentalis* L.

Mulberries
- Red mulberry .... *Morus rubra* L.

Magnolias
- Sweetbay .... *Magnolia virginiana* L.
- Yellowpoplar .... *Liriodendron tulipifera* L.

Sweetgums
- Sweetgum .... *Liquidambar styraciflua* L.

Sycamores
- American sycamore .... *Platanus occidentalis* L.

Cherries
- Black cherry .... *Prunus serotina* Ehrh.

Honeylocusts
- Honeylocust .... *Gleditsia triacanthos* L.

Maples
- Boxelder .... *Acer negundo* L.
- Red maple .... *Acer rubrum* L.

Basswoods
- American basswood .... *Tilia americana* L.

Tupelos
- Black tupelo .... *Nyssa sylvatica* Marsh.

Ashes
- White ash .... *Fraxinus americana* L.
- Green ash .... *Fraxinus pennsylvanica* Marsh.

[1] Harlow & Harrar, 1968.
[2] Clark, 1972.

APPENDIX IV

County Maps Showing Location of the Piedmont Forest Habitat Region Boundary, the Boundaries of the Ashland and Opelika Plateaus and the Devil's Backbone, and the Areas Within Which Monadnocks are Relatively Common

Key

Piedmont boundary	——	Devil's Backbone	(stippled)
Ashland-Opelika plateau boundary	-·-	Monadnock areas	(hatched)

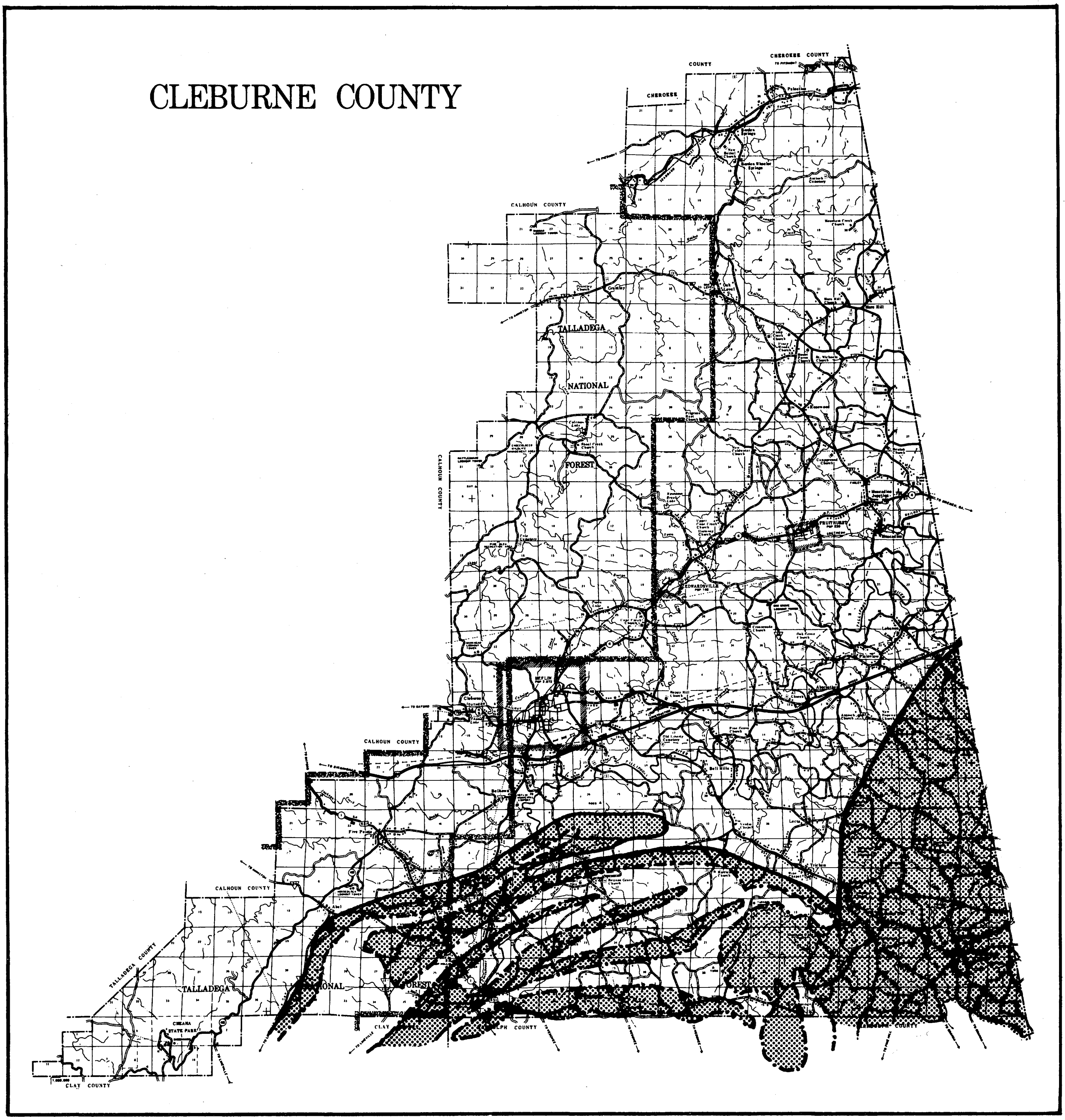


FIGURE 54.

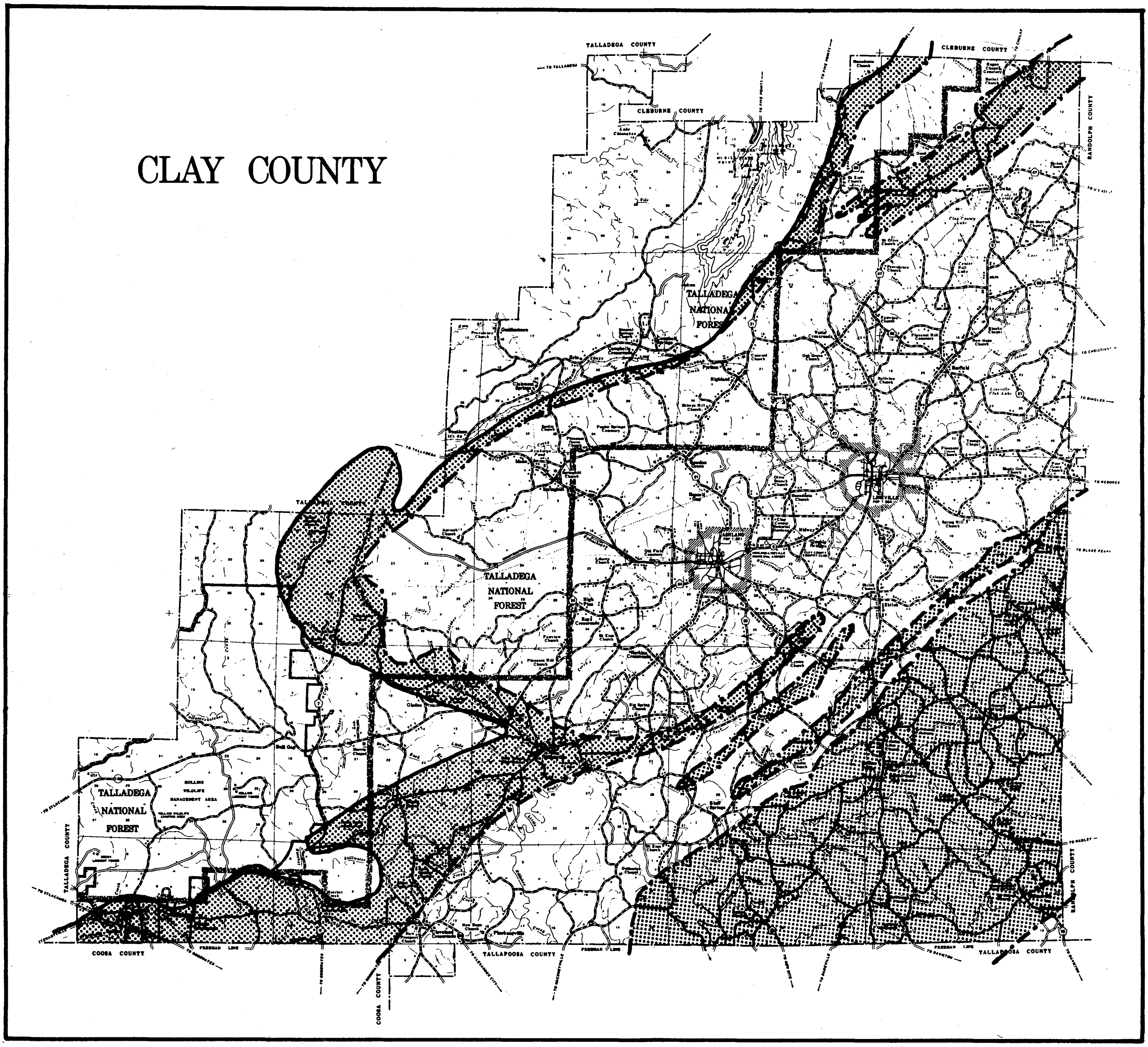
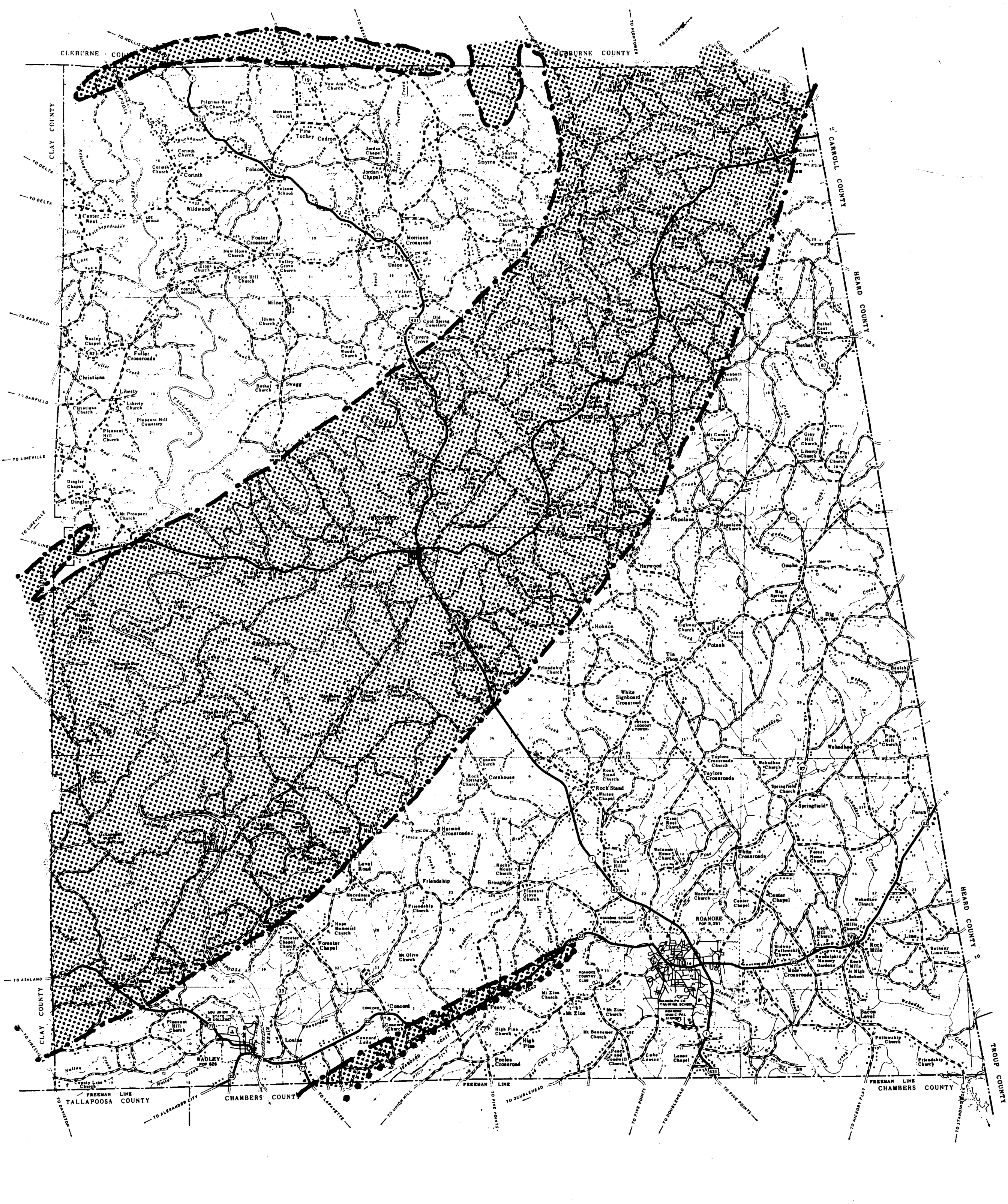

CLAY COUNTY
TALLADEGA COUNTY
CLEBURNE COUNTY
RANDOLPH COUNTY
TALLADEGA NATIONAL FOREST
TALLADEGA NATIONAL FOREST
TALLADEGA NATIONAL FOREST
COOSA COUNTY
TALLAPOOSA COUNTY
TALLAPOOSA COUNTY

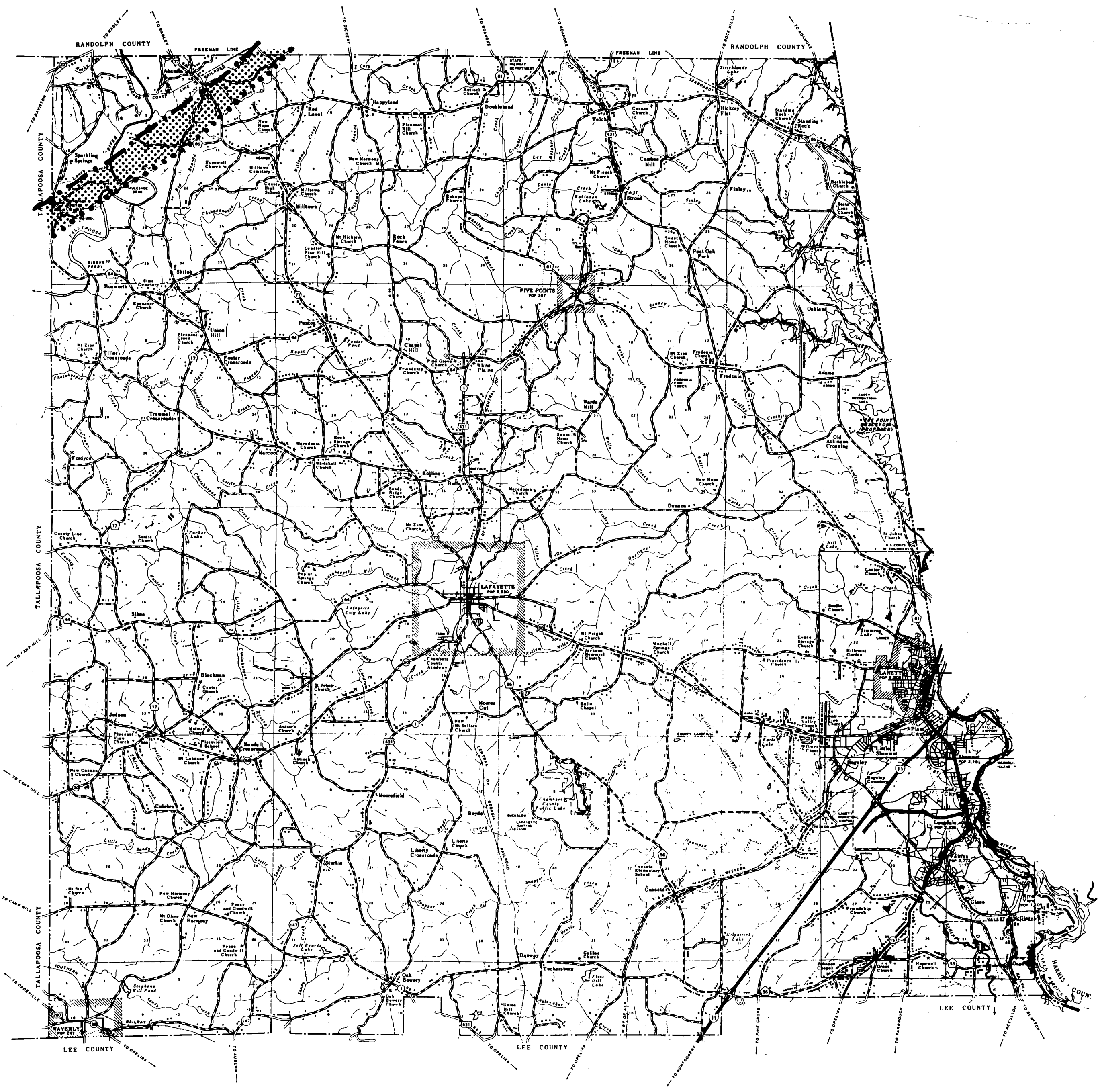
FIGURE 55.



RANDOLPH COUNTY

FIGURE 56.

CHAMBERS COUNTY



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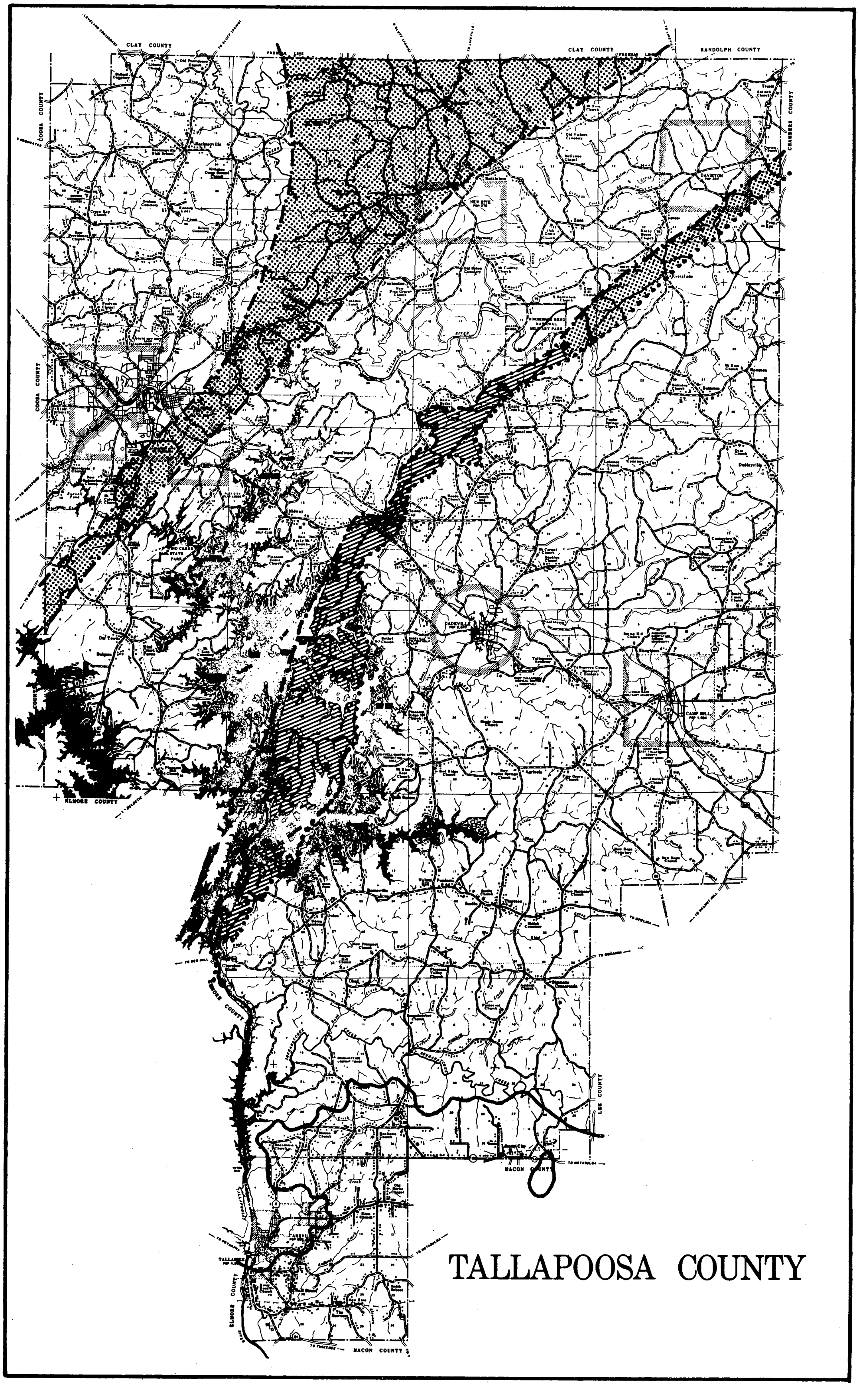

TALLAPOOSA COUNTY
CLAY COUNTY
RANDOLPH COUNTY
CHAMBERS COUNTY
COOSA COUNTY
ELMORE COUNTY
LEE COUNTY
MACON COUNTY

FIGURE 58.

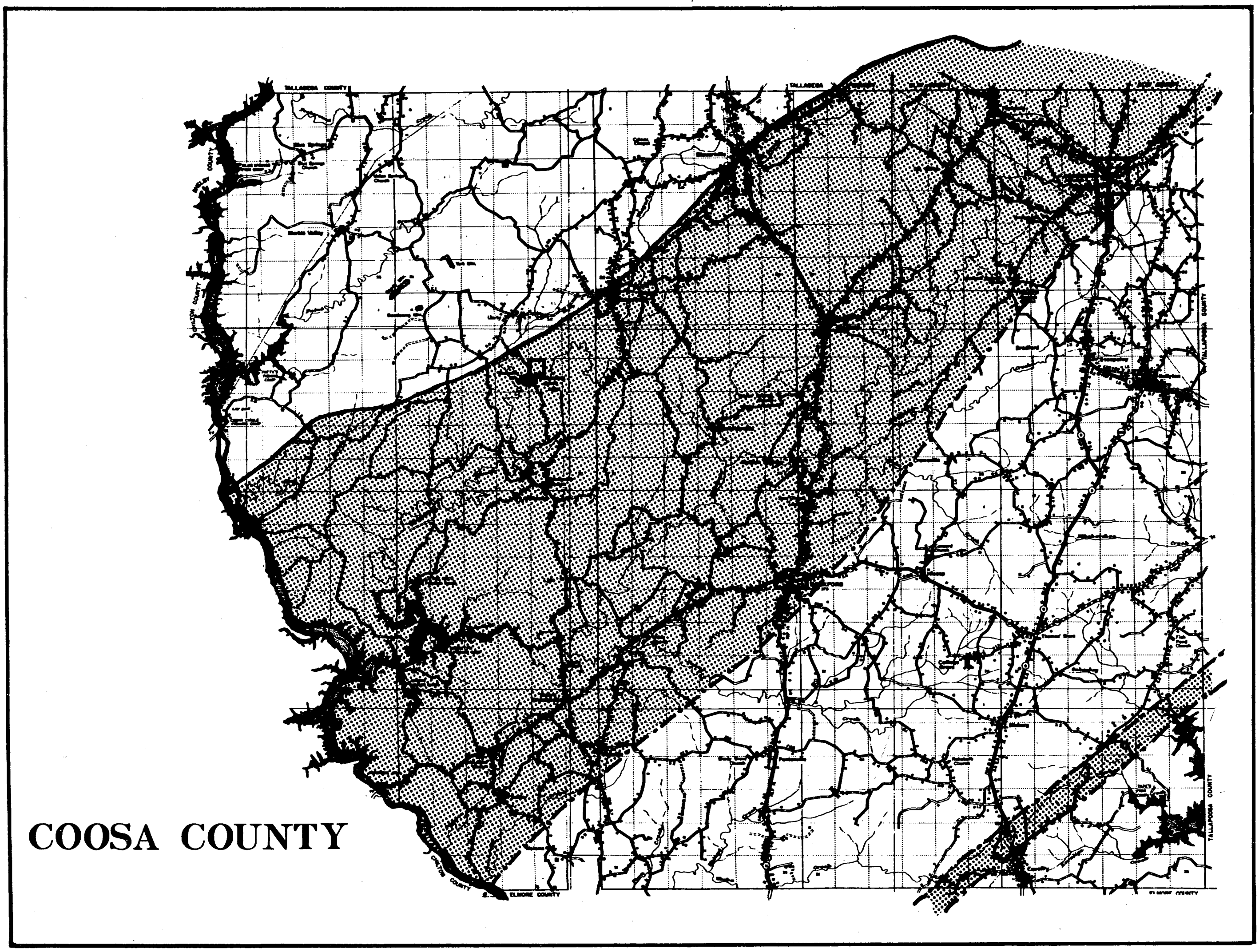
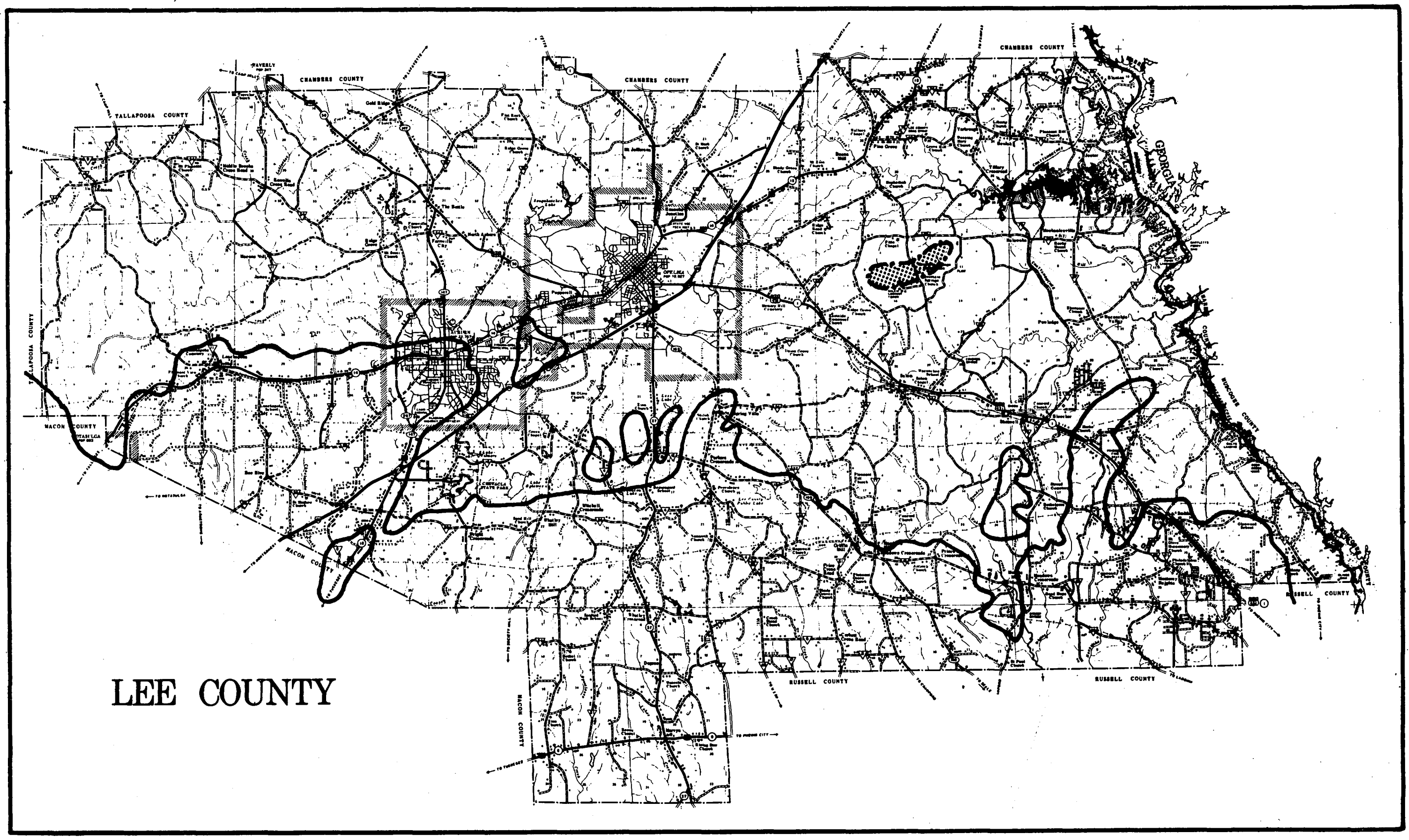


FIGURE 59.

Credit: Adams, *et al,* 1926; Deininger, *et al,* 1964; & Brackeen, 1954.



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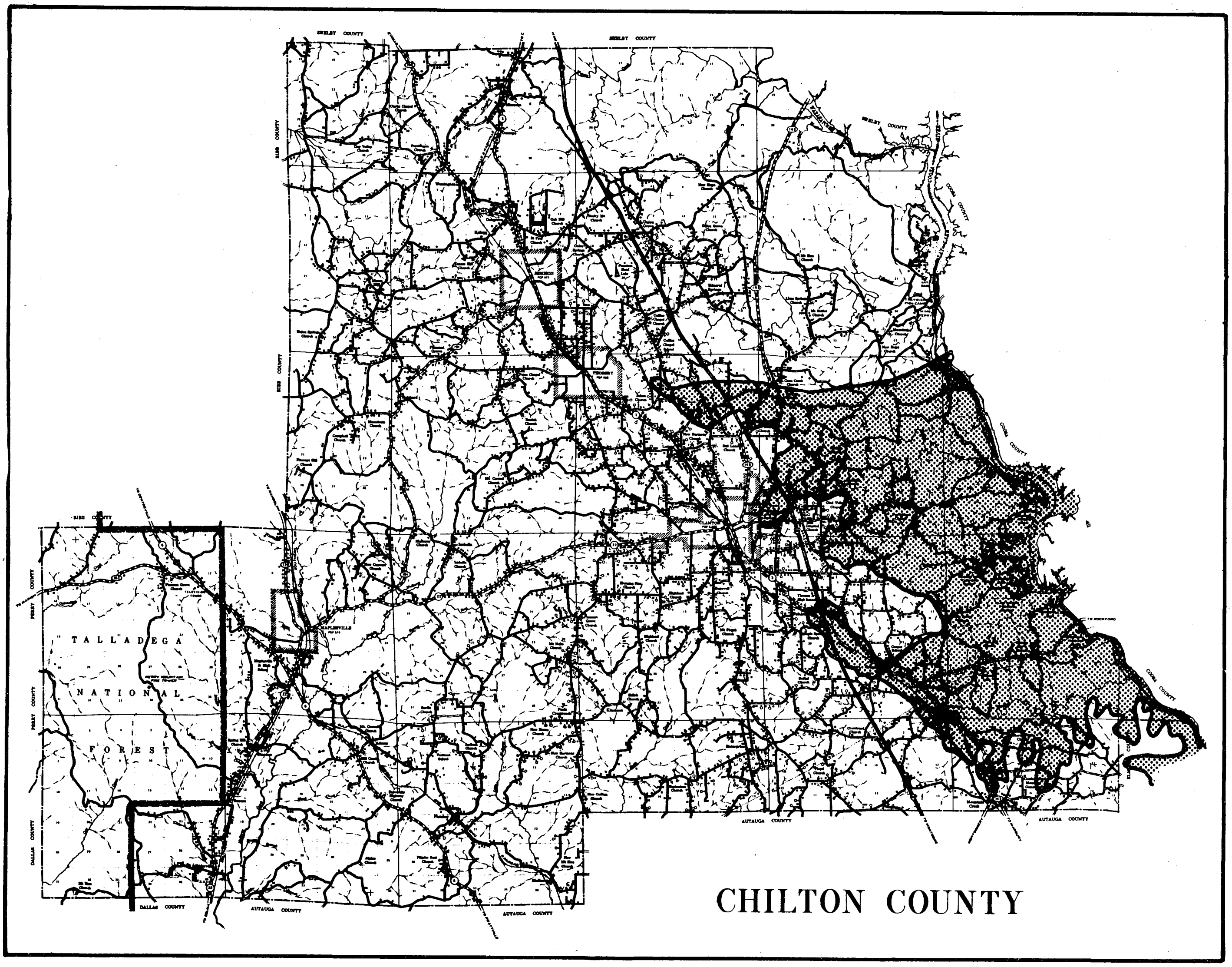


FIGURE 61.

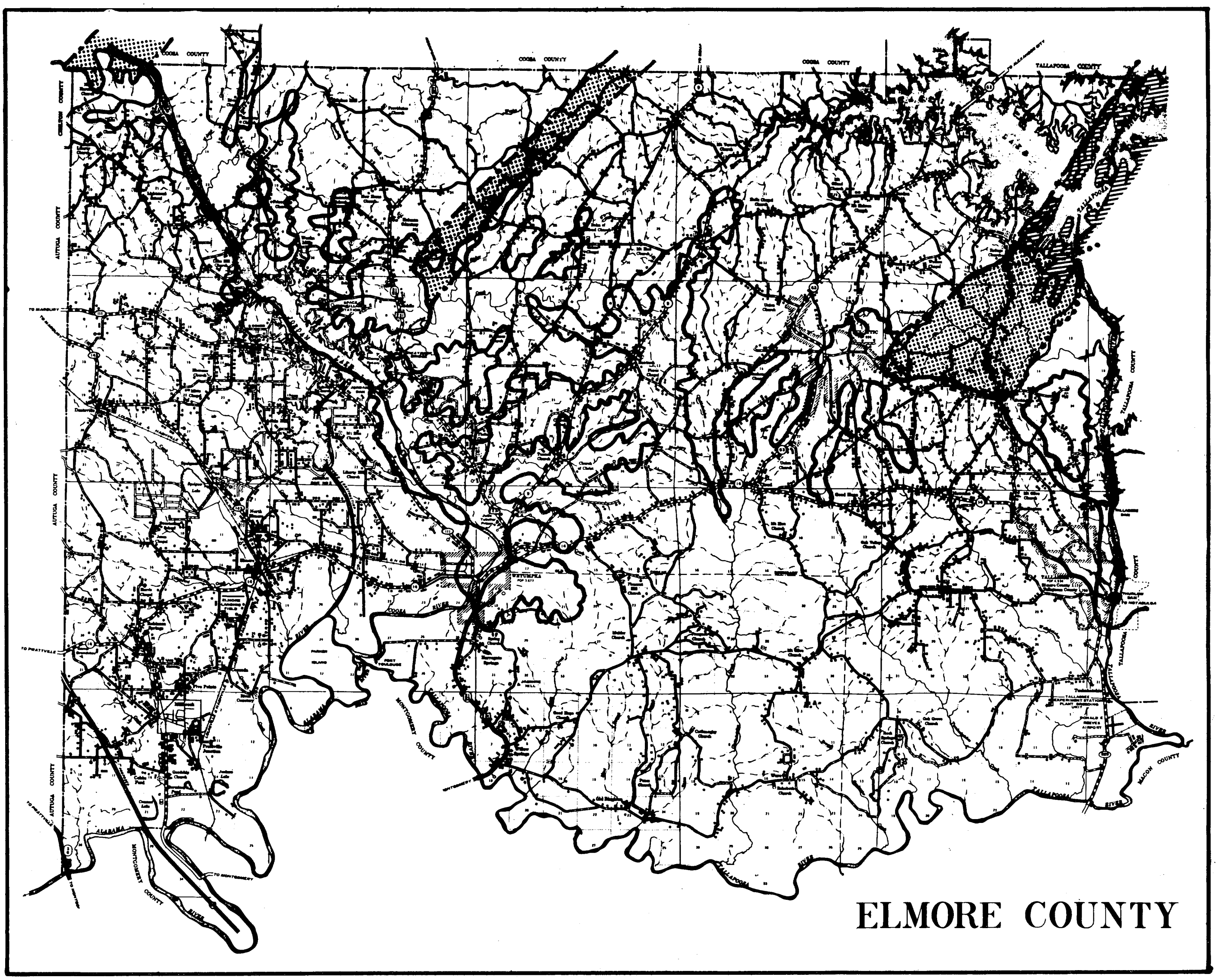


FIGURE 62.

APPENDIX V

County maps showing location of areas where Virginia Pines may be located.

Key

Virginia Pines

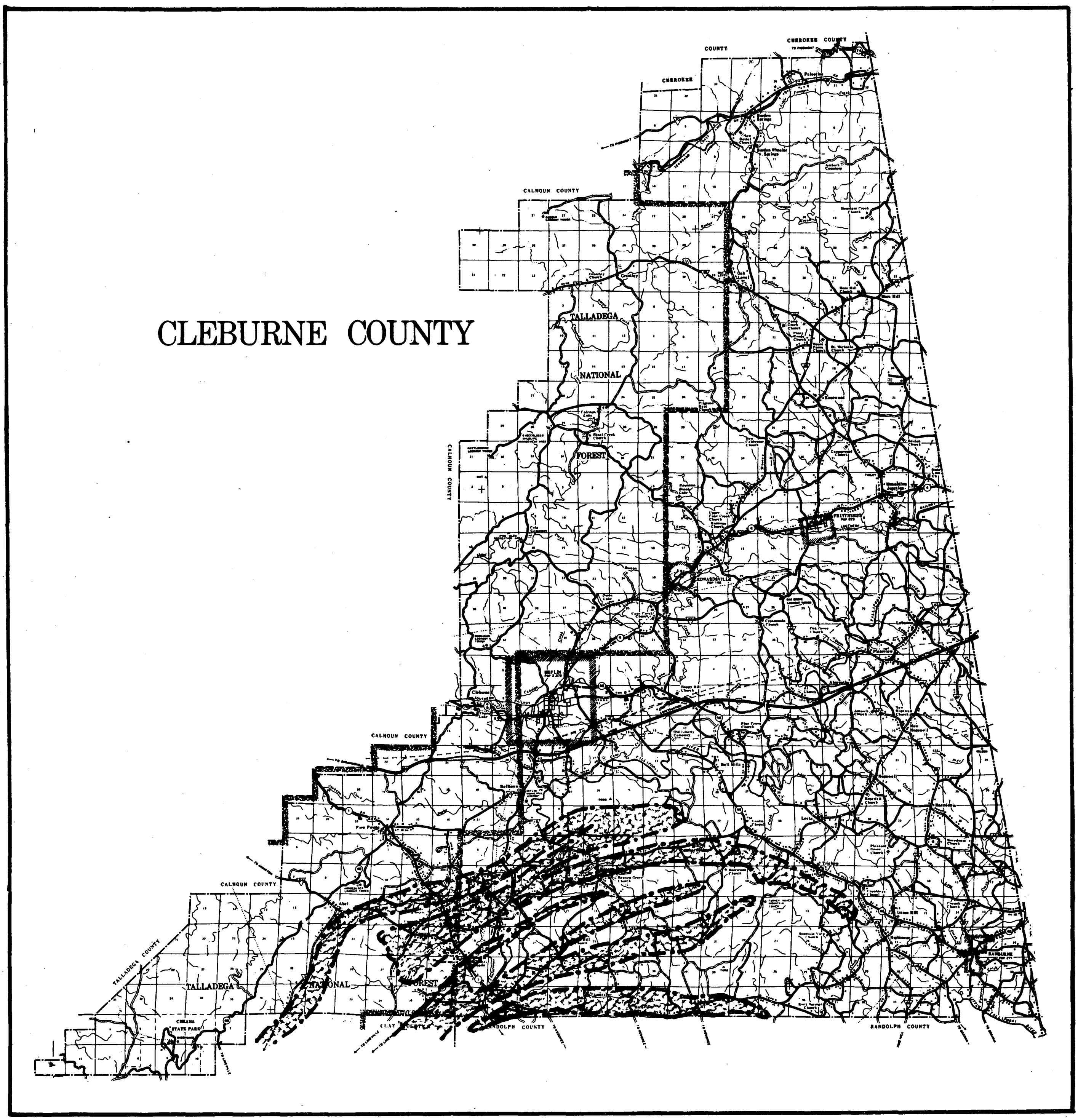


FIGURE 63.

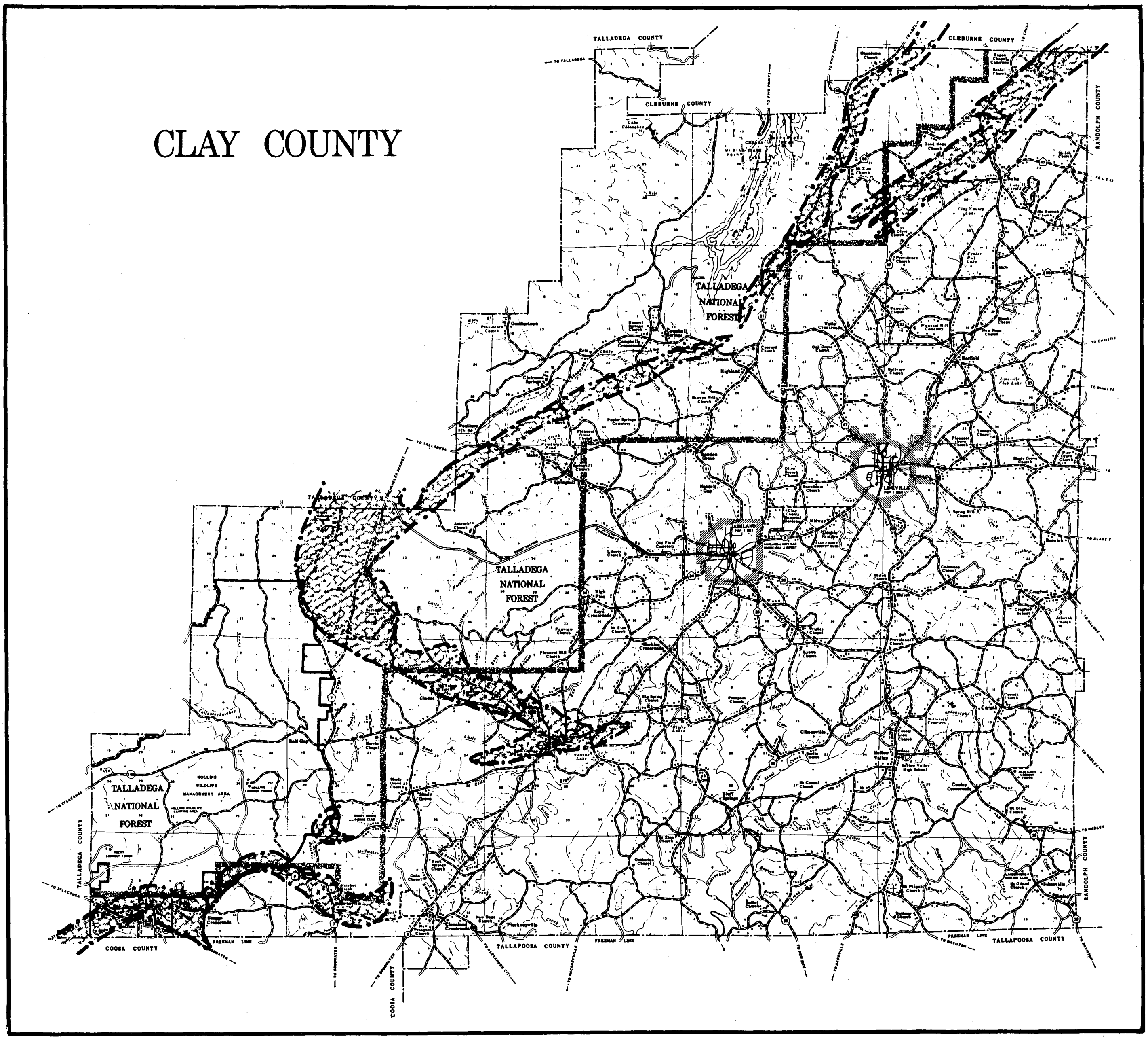
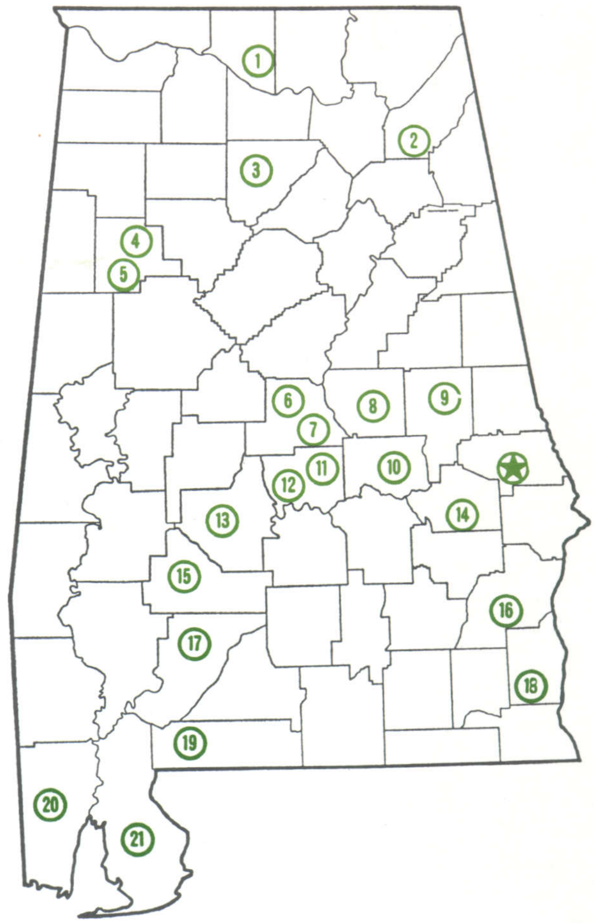

CLAY COUNTY
TALLADEGA COUNTY
CLEBURNE COUNTY
RANDOLPH COUNTY
TALLAPOOSA COUNTY
COOSA COUNTY
TALLADEGA NATIONAL FOREST
TALLADEGA NATIONAL FOREST
TALLADEGA NATIONAL FOREST

FIGURE 64.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.