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CERTAIN FLORISTIC AFFINITIES OF THE TREES AND SHRUBS OF THE GREAT SMOKY MOUNTAINS AND VICINITY

By STANLEY A. CAIN

It is widely admitted that the forests of eastern United States reach their culmination in the southern Appalachians, particularly in the Unaka range of North Carolina and Tennessee. It is in the mountains of this range that the greatest height east of the Rocky mountains is reached; in the Black mountains with Mt. Mitchell, the Craggy mountains and the Great Smoky mountains, with some forty peaks over 6,000 feet in altitude, and with Mt. Guyot and Clingman's Dome topping them all. Here on these lofty peaks (for many of them rise over a mile in altitude above their base), in a region of high rainfall and high humidity, there is a rich flora—rich in species and rich in numbers.

The arborescent flora of these mountains is essentially composed of a forest of deciduous broad-leaf trees which surround the island-like areas of coniferous vegetation on the higher mountain summits. These coniferous forests are distinctly northern in their affinities, but in the minds of the laity are associated with the country where they are found. Historically, in all likelihood, the trees of the northern forest, north of the great terminal moraine, have been derived from farther south, and, in all probability, from the higher Appalachian ranges, especially those here under consideration.

SOUTHEASTERN UNITED STATES AS A CENTER OF GEOGRAPHICAL DISTRIBUTION

Harshberger (4), in his Phytogeographic Survey, says: "The deciduous forest of eastern North America has been derived from that forest which reaches its greatest development in the mountainous region of western North Carolina and eastern Tennessee. . . . In eastern North America a large number of species came from the great mixed forest in which broad-leaved trees and conifers were intermixed. The latter were found especially, perhaps, during glacial times on the mountain tops which had remained undisturbed in their original home. At the close of the long ice age these trees were in a plastic condition through

the influence of the pressure of species and through the action of the physiographic vicissitudes to which these forms were subjected."

Sargent (7) shows in a number of valuable maps the geographic distribution of species of many important genera of trees. The geographic distribution proceeded from a territory which seems to center in the area of the present states of southern and central Pennsylvania, Maryland, West Virginia, Kentucky, Tennessee, western North Carolina, southwestern Virginia, northern Georgia, Alabama and Mississippi. A study of these maps reveals an important fact, *viz.*, that the spread of species from this common center has been in more or less concentric waves. Approximately, the trees invaded the northern part of the continent in the order indicated by their present relative position (distribution). Those farthest north entered the glaciated territory first and those farthest south advanced much more slowly. These maps show the outer confines on any particular genus is usually occupied by a single species, nearer the center two species are found, still nearer three, four and more species, if the genus is a large one.

Adams (1) takes this problem up in detail and presents evidence from many writers that Northern states and Middle-Western states show striking affinities with Southeastern states. He says: "Two post-glacial centers of dispersal have been located in the southern part of the United States. The eastern center has been located with Chattanooga, Tennessee, as the approximate center of dispersal or adaptive radiation."

From this center there have been three primary outlets or "highways" of dispersal from the southeast: (1) The Mississippi valley and valleys of tributary streams have been one very important highway—the Tennessee river playing a very important part. (2) The coastal plain, leading along the Atlantic seaboard northward and along the Gulf coast southward and southwest, is a second highway, and probably of least importance. (3) The southern Appalachians and adjacent plateaus formed an outlet to the north—probably the most important of the three.

The role of the Mississippi system in bringing woody flora to states on the upper reaches has been recognized by McMillan for Minnesota, Bessey for Nebraska, Masson for Kansas, Walker for Michigan and Coulter for Indiana. The present writer has observed that Indiana has a closer arboreal affinity with Tennessee than any other state, notwithstanding that the bordering states, Kentucky, Ohio and Michigan, are

naturally timbered, *i. e.*, that Indiana and Tennessee have more woody species in common than Indiana has with any other state.

BASIS OF CLASSIFICATION

In the preparation of this floristic study of the woody plants of East Tennessee, it was thought desirable to find a natural basis for the classification. In this connection a number of classifications were reviewed in hope that one would be suitable for the present purpose.

Consideration was given the classification of Merriam (6), which is based on temperature relations. Merriam divided the continent of North America, according to the distribution of plants and animals, into three primary transcontinental zones, called "regions," which in turn were subdivided further. The outline of his classification is as follows:

BOREAL REGION

- Arctic-Alpine zone
- Hudsonian zone
- Canadian zone

AUSTRAL REGION

- Transition zone
- Alleghanian area
- Upper Austral zone
- Carolinian area
- Austroriparian area
- Semitropical Gulf strip area

There are other divisions, of course, but they are not related to the Tennessee problem and are not considered here.

The Arctic-Alpine zone, which lies above the limit of tree growth, is not represented climatically in the Unaka range of East Tennessee. The next zone, the Hudsonian, comprises the northern part of the great transcontinental coniferous forest and is represented in the southern Appalachians by the spruce-fir forest. The Canadian zone comprises the southern parts of the great transcontinental coniferous forest in Canada and that part of it which lies in the northeastern United States. This zone is represented in the Green mountains, Adirondacks and Catskills, and also in the higher stretches of the mountains of North Carolina and Tennessee. The other zones, except the Semitropical or Gulf

strip, which is not represented in Tennessee, that is, the Transition, Alleghanian, Carolinian and Austroriparian, are found in East Tennessee in the foothills and lowlands.

Although these zones of Merriam suffer some telescoping in the Smoky mountains, they are of considerable general significance. However, on examination of the geographical ranges of the species under consideration, it was found that they did not lend themselves geographically to Merriam's life-zone classification. This is due, in part at least, to the following complications: (a) their ranges are not sufficiently accurately described in the manuals, possibly not well enough known; (b) their habitat and site preferences also are not sufficiently well enough known to permit interpretation on that basis; and (c) very large numbers of species spread over more than one life-zone, indicating that such a classification is not always successful.

Study was made of the vegetation zones described by Zon (8). For the eastern forests Zon recognizes seven principal divisions which correspond in the main to the climatic climax types. His groups are as follows:

- Spruce-fir (northern coniferous forest)
- White-Norway-jack pine forest (northeastern)
- Birch-beech-maple-hemlock (northeastern)
- Oak (southern hardwood forest)
 - Chestnut-chestnut oak-yellow poplar
 - Oak-hickory
 - Oak-pine
- Cypress-tupelo-red gum (southern)
- Longleaf-loblolly-slash pine (southeastern)
- Mangrove (subtropical)

The distribution of these forests in the state is as follows: Spruce-fir is on the highest summits of the Great Smoky mountains in the eastern part of the state. The birch-beech-maple-hemlock, or northern hardwood forest, is also in the eastern part of the state immediately below the spruce-fir on the higher slopes. Practically the whole of the state is occupied by the chestnut-chestnut oak-yellow poplar, while the oak-pine type enters the eastern part of the state from the south near Chattanooga, and is characteristic of the sand plains of Middle Tennessee. The cypress-tupelo-red gum type is in the western part of the state but is not found in East Tennessee. Within the state the

classification of species fits fairly well with these forest types, but, as in the case of Merriam's classification, it is impossible to arrange many of the species by the areas listed. There is too much overlapping, telescoping, etc.

Next are the phytogeographic regions of Harshberger (4) for the eastern part of the continent:

- I. Arctic and Subarctic zones
 1. Arctic region of Labrador, Mackenzie and Arctic shore
 2. Subarctic forest region of North Canada and Alaska
 - A. Labrador district
 - B. Hudson Bay district
 - C. Mackenzie district
 - D. Alaska district
- II. North American temperate zone: Atlantic section-
 1. St. Lawrence-Great Lakes region
 - A. Maritime district
 - a. New Brunswick area
 - b. New England area
 - B. Lake district
 - a. Interlacustrine area
 - b. Adirondack area
 2. Atlantic-Gulf coastal region
 - A. Northern Pine Barren-Strand district
 - B. Carolinian Pine Barren-Strand district
 - C. Gulf Pine Barren-Strand district
 - D. Arkansas-Louisiana district
 3. Piedmont-Appalachian-Ozark plateau region
 - A. Piedmont district
 - a. Northern area
 - b. Southern area
 - B. Appalachian district
 - a. Northern mountain area
 - b. Southern mountain area
 - C. Alleghanian-Ozark district
 - a. Lacustrine area
 - b. Kentucky-Tennessee area
 - c. Ozark area

The writer is of the conviction that the ideal treatment of the flora of East Tennessee would be one that would show the affinities of that flora with the various regions outlined above, or better, perhaps, some modification of it. These zones are both floristic and physiographic. It is not to be expected, however, that species would abide strictly by such limits. Some zones coincide with the limits of distribution of certain species, but more frequently a zone is characterized by a certain admixture of species in certain abundance, while the same species are to be found in other areas, perhaps in different abundance. After all, the most natural floristic treatment would be one that relates the distribution of species to physiographic provinces similar to those of Harshberger.

It was finally decided that the only practical classification at the present was one essentially geographic in nature, with special reference to the local physiographic areas occupied by the species in the region under consideration. This type of treatment is suggested by Cowles (2), and is followed as closely as the present situation and material will permit.

INTRANEOUS

- Eastern North America (essentially the whole of humid, temperate North America)
- Southeastern United States
- Southern Appalachian
- Endemic (essentially restricted to the Unaka and related mountain ranges)

EXTRANEOUS

- Northeastern United States
- Southeastern Canada
- Canadian Transcontinental
- Southern
- Southwestern

Those species which come under the head "Intraneous" are not, in East Tennessee, near the limits of their distribution, and are wholly indigenous. Those of the first two subgroups are wide-ranging geographically and, apparently, also in their tolerance for soils, climatic conditions, etc. The two categories remaining in the intraneous divi-

sions are essentially similar, the southern Appalachian species being of wider range than those considered as "endemic."

Of the "Extraneous" forms (those species which are, in East Tennessee, at the limits of their distribution), the first three categories are northern, while the other two are southern. The northern species owe their presence in Tennessee to the Appalachian mountains, which provide climatic conditions duplicating those found in their main ranges, sometimes hundreds of miles farther north. The three categories are formed on the extent of their northern range, *i. e.*, those with their main distribution in northeastern United States; those extending into southern Canada; and lastly those which, in Canada, extend across the continent. Of the latter species, some are circumpolar, extending into northern Europe and Asia, others of them find southern extension in the mountains of the West, similar to that here described for the Eastern mountains.

The following classification of woody species would have been very incomplete without the use by the writer of a list of woody plants of East Tennessee prepared by Galyon (3). The writer has collected many and observed some 75 per cent of the species here considered. Miss Galyon's check list is completely backed by herbarium specimens deposited at the University of Tennessee, Knoxville, Tennessee.

The nomenclature follows Gray's Manual, 7th edition, as far as possible; for the remainder Small's Manual is used. An asterisk before the name of a species indicates its addition to Miss Galyon's check list by the writer. The geographic ranges are, in the main, from manual descriptions.

INTRANEOUS

I A. EASTERN NORTH AMERICA (Essentially the whole of humid, temperate North America)

- Acer negundo L.
- A. nigrum Michx.
- A. rubrum L.
- A. saccharinum L.
- A. saccharum Marsh.
- Alnus rugosa (DuRoi.) Spreng.
- Amelanchier canadensis (L.) Med.
- Asimina triloba Dunal.

Betula nigra L.
 Carpinus caroliniana Walter.
 Carya alba (L.) K. Koch.
 C. laciniosa (Michx. f.) Loud.
 C. ovata (Miller) K. Koch.
 Ceanothus americanus L.
 Celastrus scandens L.
 Celtis occidentalis L.
 Cephalanthus occidentalis L.
 Cercis canadensis L.
 Cornus alternifolia L. f.
 C. amomum Miller.
 C. asperifolia Michx.
 C. florida L.
 Diospyros virginiana L.
 Dirca palustris L.
 *Epigæa repens L.
 Evonymus americana L.
 E. atropurpureus Jacq.
 Fagus grandifolia Ehrh.
 Fraxinus americana L.
 *F. nigra Marsh.
 *Gaultheria procumbens L.
 Gaylussacia frondosa (L.) T. & G.
 Gleditsia triacanthos L.
 Hamamelis virginiana L.
 Hydrangea arborescens L.
 Ilex opaca Aiton.
 Itea virginica L.
 Juglans nigra L.
 Juniperus virginiana L.
 Kalmia latifolia L.
 Liquidamber styraciflua L.
 Liriodendron tulipifera L.
 Lyonia ligustrina (L.) DC.
 Magnolia acuminata L.
 Morus rubra L.
 Nyssa sylvatica Marsh.

Ostrya virginiana (Miller) K. Koch.
Pinus echinata Miller.
Platanus occidentalis L.
Prunus americana Marsh.
P. serotina Ehrh.
Ptelea trifoliata L.
Pyrus augustifolia Ait.
P. arbutifolia (L.) L. f.
Quercus alba L.
Q. marilandica Muench.
Q. muhlenbergii Eng.
Q. prinus L.
Q. rubra L.
Q. stellata Wang.
Q. velutina Lam.
Rhododendron maximum L.
R. nudiflorum (L.) Torr.
R. viscosum (L.) Torr.
Rhus canadensis Marsh.
R. copallina L.
R. glabra L.
R. vernix L.
Rosa carolina L.
R. humilis Marsh.
R. setigera Michx.
Rubus cuneifolius Pursh.
R. hispidus L.
R. villosus Ait.
Salix discolor Muhl.
S. nigra Marsh.
S. tristis Ait.
Sambucus canadensis L.
Sassafras variifolium (Salisb.) Kuntze.
Symphoricarpos orbiculatus Muench.
**Tilia americana* L.
**T. michauxii* Nutt.
Ulmus fulva Michx.
U. americana L.

Vaccinium corymbosum L.
**V. vacillans* Kalm.
Viburnum cassinoides L.
V. dentatum L.
V. prunifolium L.

I B. SOUTHEASTERN NORTH AMERICA (Essentially more characteristic of the Southern states)

Æsculus glabra Willd.
A. pavia L.
Aralia spinosa L.
Bumelia lycioides (L.) Gartner f.
Castanea pumila (L.) Miller.
Celtis occidentalis L. var. *crassifolia* (Lam.) Gray.
Chionanthus virginica L.
Halesia carolina L.
Leucothoe racemosa (L.) Gray.
Lyonia mariana (L.) D. Don.
**L. ligustrina* (L.) DC.
 var. *foliosiflora* (Michx.) Fernald.
Magnolia macrophylla Michx.
M. tripetala L.
Oxydendrum arboreum (L.) DC.
Prunus hortulana Bailey.
Quercus nigra L.
Rhamnus caroliniana Walter.
Rhus toxicodendron L.
Rosa andrewsianus Blanchard.
Rubus trivialis Michx.
Stewartia malacodendron L.
Tilia heterophylla Vent.
Ulmus alata Michx.
Vaccinium arboreum Marsh.
V. melanocarpum C. Mohr.
Viburnum nudum L.
V. rufidulum Raf.

I C. SOUTHERN APPALACHIAN (Essentially in the mountains and adjacent uplands)

- Æsculus octandra* Marsh.
- A. octandra* var. *hybrida* (DC.) Sarg.
- Berberis canadensis* Miller.
- Calycanthus fertilis* Walt.
- C. floridus* Britt.
- Cladrastis lutea* (Michx. f.) Koch.
- Clethra acuminata* Michx.
- Cratægus biltmoreana* Bead'le.
- C. phænopyrum* (L. f.) Med.
- Decumaria barbara* L.
- Gaylussacia brachycera* (Michx.) Gray.
- Ilex monticola* A. Gray.
- I. monticola* Gray, var. *mollis* (Gray) Britt.
- **Menziesia pilosa* (Michx.) Pers.
- Nestronia umbellata* Raf.
- Philadelphus grandiflorus* Willd.
- P. inodorus* L.
- Pinus pungens* Lam.
- P. virginiana* Miller.
- Pyralaria pubera* Michx.
- Rhododendron arborescens* (Pursh.) Torr.
- R. calendu'aceum* (Michx.) Torr.
- Rhus quercifolia* (Michx.) Steudel.
- Robinia hispida* L.
- R. pseudo-acacia* L.
- Stewartia pentagyna* L'Her.

I D. ENDEMIC (Essentially in the Unaka range of eastern Tennessee and western North Carolina, centering in the great Smoky mountains)

- Abies fraseri* (Pursh.) Poirét.
- Andromeda floribunda* Pursh.
- Buckleya distichophylla* (Nutt.) Torr.
- Carya*, see *Hicoria*.
- **Celtis smallii* Beadle.
- Cratægus austro-montana* Beadle.
- C. boyntonii* Beadle.

C. buckleyi Beadle.
C. macrosperma Ashe.
C. rubella Beadle.
C. sargentii Beadle.
C. straminea Beadle.
C. vailiæ Britt.
Dendrium prostratum (Loud.) Small.
Diervilla rivularis Gattinger.
 **D. sessilifolia* Buckley.
Fothergilla gardeni Murray.
Hicoria carolinæ-septentrionalis Ashe.
Hydrangea cinerea Small.
Leucothoe catesbæi (Walter) Gray.
L. recurva (Buckley) Gray.
Magnolia fraseri Walter.
Philadelphus hirsutus Nutt.
Rhododendron catawbiense Michx.
R. punctatum Andrews.
Robinia viscosa Vent.
Spiræa virginiana Britt.
Tsuga caroliniana Engel.
Vaccinium corymbosum L. var. *pallidum* (Ait.) Gray.
V. erythrocarpum Michx.
V. hirsutum Buckley.

EXTRANEOUS

II A. NORTHEASTERN UNITED STATES (Essentially southern extensions in the Appalachians)

Benzoin æstivale (L.) Nees.
Betula lenta L.
Carya glabra (Mill.) Spach.
C. microcarpa (Nutt.) Britt.
Castanea dentata (Marsh.) Borkh.
Cornus paniculata L'Her.
Corylus americana Walter.
C. rostrata Ait.
Cratægus crus-gali L.
C. punctata Jacq.

C. tomentosa L.
Fraxinus pennsylvanica Marsh.
F. quadrangulata Michx.
Gymnocladus dioica (L.) Koch.
Juglans cinerea L.
Physocarpus opulifolius (L.) Michx.
Pinus rigida Miller.
Prunus alleghaniensis Porter.
Pyrus coronaria L.
P. melanocarpa (Michx.) Willd.
Quercus coccinea Wang.
Q. ilicifolia Wang.
Q. macrocarpa Michx.
Q. palustris Muench.
Q. prinoides Willd.
Ribes rotundifolium Michx.
Rubus alleghaniensis Porter.
R. canadensis L.
R. occidentalis L.
R. odoratus L.
Salix sericea Marsh.
Staphylea trifolia L.
Tsuga canadensis (L.) Carriere.
Ulmus racemosa Thomas.
Vaccinium stamineum L.
Viburnum acerifolium L.
V. alnifolium Marsh.

II B. SOUTHEASTERN CANADA AND NORTHEASTERN UNITED STATES
(Essentially southern extensions in the Appalachians)

Acer pennsylvanicum L.
A. spicatum LaMarck.
Alnus mollis Fernald.
Betula lutea Michx.
Crataegus rotundifolia Borkh.
Gaylussacia baccata (Wang.) K. Koch.
Picea rubra Link.
Pinus strobus L.
Populus grandidentata Michx.

Prunus virginiana L.
Pyrus americana (Marsh) DC.
Rhus typhina L.
Ribes cynosbati L.
R. prostratum L'Her.
Salix humilis Marsh.
Thuja occidentalis L.
Vaccinium pennsylvanicum Lam.

II C. CANADIAN TRANSCONTINENTAL (Of wide northern distribution, with southern extensions in the mountains)

Alnus crispa (Ait.) Pursh.
Cornus stolonifera Michx.
Diervilla lonicera Miller.
Picea mariana (Mill.) B. S. P. (?).
Prunus pennsylvanica L. f.
Rubus idæus L. var. *aculeatissimus* (Mey.) R. T.
Salix lucida Muhl.
Sambucus racemosa L.
Spiræa salicifolia L.

II D. SOUTHERN (Piedmont, Coastal plain or Mississippian, essentially southern lowland, with northern extension into Tennessee in lowlands)

Catalpa speciosa Warder.
Celtis mississippiensis Bosc.
Nyssa aquatica L.
N. biflora Walt.
Pinus tæda L.
Quercus pagodæfolia (Ell.) Ashe.
Q. phellos L.
Vaccinium virgatum Ait.
V. virgatum Ait. var. *tenellum* (Ait.) Gray.

II E. SOUTHWESTERN (Here on the northeastern limits of their extension)

Acer leucoderme Small.
Prunus angustifolia Marsh.
Quercus texana Buckley.
Maclura pomifera (Raf.) Schneider.

SUMMARY

GEOGRAPHIC AFFINITIES OF THE WOODY FLORA OF MOUNTAINOUS EAST TENNESSEE

Geographic Areas	No. Species	Percentages
I. Intraneous		
A. Eastern North America.....	89	36
B. Southeastern North America.....	27	11
C. Southern Appalachian	26	10
D. Endemic	30	12
Total	172	69
II. Extraneous		
A. Northeastern United States.....	37	15
B. Southeastern Canada	17	7
C. Canadian Transcontinental	9	3.6
D. Southern, Piedmont, etc.....	9	3.6
E. Southwestern	4	1.6
Total	76	31
Grand total	248	100

DISCUSSION OF FLORISTIC STATISTICS

There are one or two facts here revealed which are striking. Most conspicuous, I believe, is the small percentage of southern species in the flora, less than 6 per cent. That eastern Tennessee should have so small a number of trees and shrubs characteristic of the southern Piedmont, Gulf strip and Lower Mississippi flora is striking; but when one considers the topography of East Tennessee it seems more proper. The extent and the high altitude of the southern Appalachians (culminating in the Great Smoky mountains) accounts for the relative absence of southern forms because of the actual scarcity of climatic and edaphic situations suitable for such a flora.

Thus viewed it seems quite reasonable that the remaining extraneous species, 25.6 per cent of the total, should be northern in the bulk of their distribution, extending into Tennessee along the very mountains which prevent the southern species from occupying the territory.

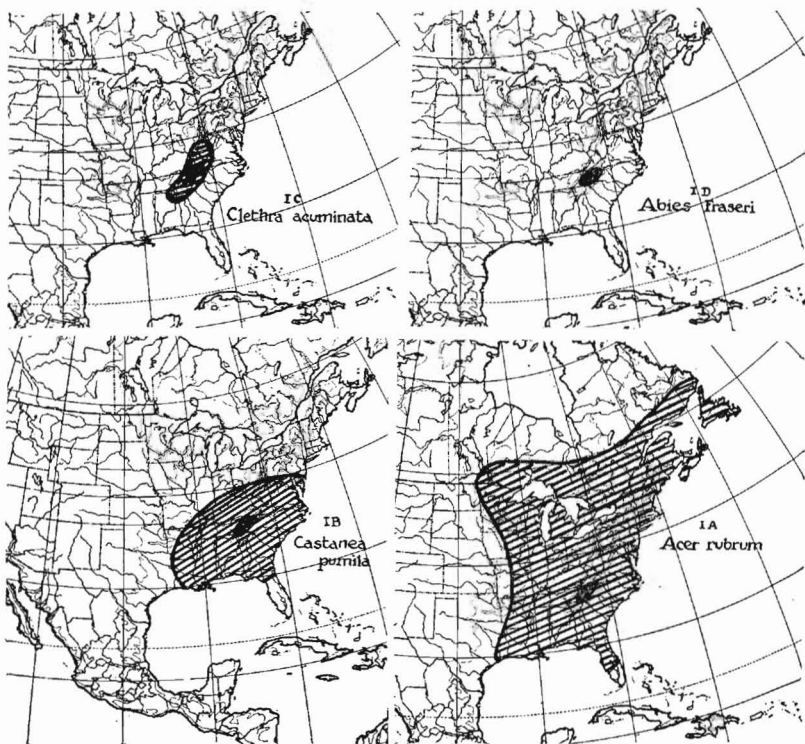
The third point of interest is the relatively high per cent of endemics for a continental region, namely 12 per cent. This high percentage of endemism is explainable on a basis of the extreme age of the territory. Conversely, it is hard to understand why many of the endemic species have not migrated from their restricted area in the mountains and enlarged the extent of their territory. Their local dominance, as in the case of *Abies fraseri*, *Rhododendron catawbiense*, *R. punctatum*, etc., is not compatible with an explanation based on lack of aggressiveness, nor is it in agreement with an idea of their recent origin. It is probably due to the restriction of suitable habitat. Adding to the endemic flora those species of somewhat wider distribution, we find almost one-fourth of the trees and shrubs here listed are confined to the southern Appalachians.

Lastly, the presence of extremely northern forms in relatively great abundance is not wholly explained on a basis of the mountain chain offering suitable climatic conditions. It would be possible, of course, for northern forms to have migrated southward along the mountains, occupying the suitable places, although great gaps in the mountains prevent climatic continuity. The reverse is more likely for the majority of the species—the northern species should be viewed as glacial relics. During glaciation, when all vegetation was forced to migrate southward, the southern Appalachians were undoubtedly the great stronghold of northern forms, from which center the northward migration has been continuing since the recession of the ice sheet.

MAPS

The following maps present nine species ranges which can represent the geographic categories used in the present floristic study:

- IA. Eastern North America—*Acer rubrum* L.
- IB. Southeastern North America—*Castanea pumila* (L.) Mill.
- IC. Southern Appalachian—*Clethra acuminata* Michx.
- ID. Endemic—*Abies fraseri* (Pursh.) Poir.
- IIA. Northeastern United States—*Betula lenta* L.
- IIB. Southeastern Canada—*Betula lutea* Michx.
- IIC. Canadian Transcontinental—*Prunus pennsylvanica* L. f.
- IID. Southern (Piedmont, etc.)—*Celtis mississippiensis* Bosc.
- IIE. Southwestern—*Acer leucoderme* Small.



EXPLANATION OF MAPS—PLATE VI

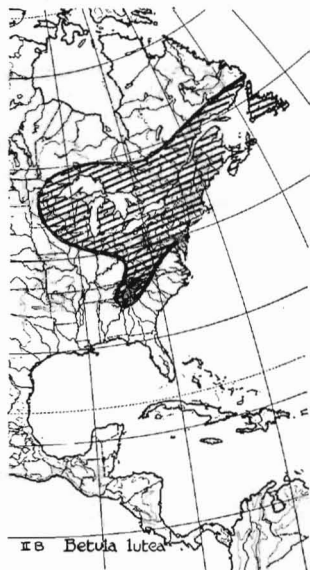
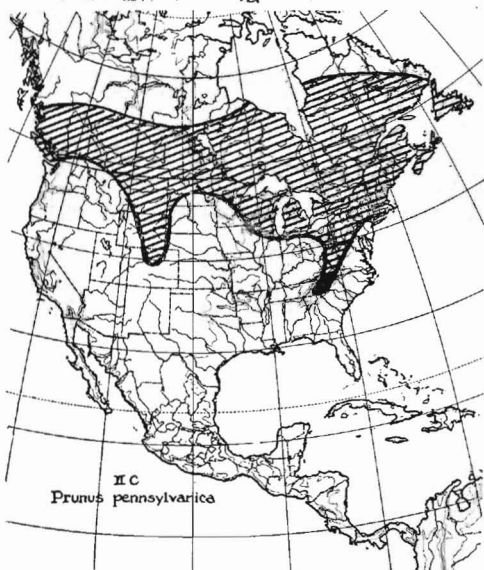
INTRANEOUS DISTRIBUTIONS

Map IA (lower right hand corner)—*Acer rubrum*, representative of eastern North America.

Map IB (lower left hand corner)—*Castanea pumila*, southeastern North America.

Map IC (upper left hand corner)—*Clethra acuminata*, southern Appalachians.

Map ID (upper right hand corner)—*Abies fraseri*, endemic.



EXPLANATION OF MAPS—PLATE VII

EXTRANEEOUS DISTRIBUTIONS

Map II A (upper left hand corner)—*Betula lenta*, northeastern United States.

Map II B (lower right hand corner)—*Betula lutea*, southeastern Canada.

Map II C (lower left hand corner)—*Prunus pennsylvanica*, Canadian transcontinental.

Map II D (upper middle)—*Celtis mississippiensis*, southern.

Map II E (upper right hand corner)—*Acer leucoderme*, southwestern.

ORIGIN OF MOUNTAIN ELEMENTS

There are many plants in the mountains of the South which are probably more or less modified descendants of that characteristic flora which in later Miocene time extended to high northern latitudes, also occupying the mountainous region of what is now the north temperate zone. Harshberger lists, from DeSaporta and Marion, a number of species which probably fall in this category:

Danthonia sericea Nutt.	Arundinaria tecta Walt.
Uniola gracilis Michx.	<i>Ulmus alata</i> Michx.
Poa chapmaniana Schibn.	Parnassia grandifolia DC.
Arundinaria macrosperma Michx.	<i>Decumaria barbara</i> L.
Lilium carolinianum Michx.	<i>Itea virginica</i> L.
<i>Cratægus rotundifolia</i> Ehr.	<i>Cratægus uniflora</i> Muench.
Berchemia volubilis Hill.	<i>Leucothoe racemosa</i> L.
<i>Cissus ampelopsis</i> Pers.	<i>Oxydendrum arboreum</i> (L.) DC.
<i>Vitis rotundifolia</i> Michx.	<i>Gaylussacia dumosa</i> Andr.
<i>Aralia spinosa</i> L.	<i>Batodendron arboreum</i> Marsh.

Those in italic are woody species reported, in the present paper, from East Tennessee. Harshberger says of this group of plants: "Most of the species, as well as many of the genera, are characteristic of neither tropic nor northern regions. They belong in great part to groups which are mostly represented at present in the mountainous parts of the warm belt of the north temperate zone, in both eastern and western hemispheres."

It is not within the scope of this paper, but should be mentioned, that this affinity of southeastern United States and western China has been adequately discussed by such famous botanists of the past as Hooker, Gray, Darwin, Sargent, *et al.*

POSITION IN THE SMOKY MOUNTAINS OF PLANTS OF THE VARIOUS AFFINITIES

The spruce-fir forest of the upper slopes, 5,000-6,600 feet in altitude, is definitely northern in its affinities.

Eastern North America

Amelanchier canadensis (L.) Med.

Cornus alternifolia L. f.

Southern Appalachian	
<i>Ilex monticola</i> A. Gray.	
Endemic	
<i>Abies fraseri</i> (Pursh.) Poiret.	
<i>Dendrium prostratum</i> (Loud.) Small.	
<i>Leucothoe catesbæi</i> (Walter) Gray.	
<i>Rhododendron catawbiense</i> Michx.	
<i>R. punctatum</i> Andrews.	
<i>Vaccinium erythrocarpum</i> Michx.	27%
Northeastern United States	
<i>Betula lenta</i> L.	
<i>Rubus canadensis</i> L.	
<i>Viburnum alnifolium</i> Marsh.	14%
Southeastern Canada	
<i>Acer pennsylvanicum</i> L.	
<i>A. spicatum</i> LaMarck.	
<i>Betula lutea</i> Michx.	
<i>Picea rubra</i> Link.	
<i>Pyrus americana</i> (Marsh.) DC.	
<i>Ribes glandulosum</i> Grauer.	27%
Canadian Transcontinental	
<i>Diervilla lonicera</i> Mill.	
<i>Picea mariana</i> (Miller) Britt.	
<i>Prunus pennsylvanica</i> L. f.	
<i>Sambucus racemosa</i> L.	18%
	<hr/>
	Northern total, 59%

While the total woody flora is revealed to contain 26 per cent of northern elements, the spruce-fir forest is found to have a total of 59 per cent of northern elements which find the limits of their southern distribution in the Great Smoky mountains or their vicinity. This massing of northern species is entirely to be expected at the higher altitudes. The so-called northern hardwood forests, mixed, or frequently separated into consociations, as the beech consociation, or the birch consociation, also contain a large per cent of northern elements. At lower altitudes there are increasingly lower per cents of northern elements and increasing higher numbers of widely distributed intraneous species. Kearney (5) has pointed out the southern and coastal plain affinities

of certain pine woods of lower altitudes, around 1,200 and 1,500 feet, a correlation which the writer is planning to elaborate in a forthcoming paper dealing with the pine-heath occurring in the vicinity of 3,000 feet and higher on dry southern slopes.

SUMMARY

1. An attempt is made in this paper to view the affinities of the woody species of the Great Smoky mountains on a dual basis. The species are arranged, in the first place, according to their main geographical distributions—whether they are intraneous or extraneous, southern, northern, Canadian transcontinental, etc. Secondly, these geographic classes are considered in respect to their location in the Great Smoky mountains.

2. *Intraneous* species, *i. e.*, those which, in the Smoky mountains, are well within their ranges, constitute 69 per cent of the 248 woody species considered. The remaining 31 per cent of the woody species are to be considered *extraneous*, that is, they are northern or southern extensions or disjuncts into the Smoky mountains and have their main distributions elsewhere.

3. Of particular interest are the following percentages:

a. Twenty-two per cent of the flora is southern Appalachian, while 12 per cent of that group is essentially endemic to the Unaka range, of which the Great Smoky mountains constitute the major portion.

b. Of the extraneous species, 26 per cent are southern extensions of northern species, whereas only 5 per cent are southern; a situation which is clearly related to the mountainous conditions.

4. In the mountains the northern elements appear in increasing importance with increasing altitude until the climax is reached in the spruce-fir zone, with 59 per cent of its woody flora made up of northern species.

I wish to thank Prof. George D. Fuller, of the University of Chicago, and Prof. H. M. Jennison, of the University of Tennessee, for reading the manuscript. The responsibility for errors in the paper rests entirely with the writer. It should be noted that the distributions of species are those described in the manuals. The labor of a more detailed check of distribution is not warranted by the value of the paper.

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