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BEHIND THE REMARKABLE FLORISTIC DIVERSITY IN VIRGINIA

Sketch of the Plant Geography

Preamble. The flora of Virginia is an intricate collage of relict and Holocene populations formed by vast migrations driven by powerful climatic changes, and by areal extinctions resulting from environmental stress, all within a period of about 23,000 years. Thus, these patterns of distributions are reflections of migration pathways and differential persistence through intervals of climatic changes.

An analysis of the ranges of 200 native dicotyledonous species, taken at random, shows that 65% are southern in distribution with the bulk of their populations south of the Mason-Dixon line, and 35% are northern. Major phytogeographic elements are Southern (116 species), Northern (70) and Southern Appalachian (14). There are also five species endemic to this flora: *Helenium virginicum, Betula uber; Clematis addisonii, C. coactilis* and *C. viticaulis*. And Wisconsin and Holocene relict populations abound.

Wisconsin Migrations. With changing climate bringing glaciations to northern North America about 23,000 B.P., species of the Northern Element migrated en masse southward with a strong trend to the southwest due to the Coriolis effect, and many of them now persist as relict populations in western, northern and eastern Virginia. Needless to say, they greatly complicate the distributional picture of our flora.

Northern Migrations. About 23,000 B.P. while glaciers were building and tying up enormous quantities of water, vast areas of land became exposed by falling sea levels. At this time plants near the coast started migrating to the east, north and south on the greatly expanded coastal plain. Those species which were extremely sensitive to moisture became members of the "coastal plain" flora which is discussed in the next section. Those species occurring inland started their northern and northeastern migrations from southern midwestern and southeastern regions about 16,500 B.P. Their northeastward trend was due to the Coriolis effect abetted by prevailing winds.

The Southwestern Virginia Gap. Among the 1,439 native dicotyledonous species in Virginia, a remarkable 51% also occur in Texas. Seventy-eight of the dicot species have a gap in their distribution in southwestern Virginia. All 78 are southern species whose northward migrations were impeded by high mountains south of our border, leaving a sort of distributional "rain shadow" effect in our region.

Relict Populations. Beyond these 78 species, another 74 have significant disjunctions between the western and eastern areas of the state. Many of the relict populations in eastern Virginia persisted on marl through the Holocene xeric interval from about 8500 to 4000 B.P. They are most notable in Surry, Isle of Wight, York, James City, and Gloucester counties.

Many of the relict populations in western Virginia are remnants of the once-widespread "coastal plain" flora, which was decimated inland when the climate changed from oceanic to continental between 9,000 and 8,000 B.P. These relict colonies are most abundant in wetlands of Augusta County and vicinity.

Protorelicts. Most intriguing, however, is small number of species which do not fit at all into the pathways and patterns of the Wisconsin-Holocene cycle of migrations. Ten of these are listed below. All have major disjunctions of populations between the Middle West and our area. Although long-distance dispersal is often invoked to explain such problems, it may well be that they are relicts of a pre-Wisconsin cycle of migrations. We might call them *protorelicts*.

Trillium puslllum	**Phacelia ranunculacea**
Berberis canadensis	**Lysimachia radicans**
Paronychia virginica	**Anemone berlandieri**
Sedum telephoides	**Cimicifuga rubifolia**
Astragalus distortus	**Bacopa rotundifolia**

Summary. Virginia appears to have been a pivotal region for the vegetation of eastern North America, for its flora is largely the product of vast migrations from the north in the Wisconsin, then from the southwest and south in late Wisconsin and the Holocene, with Wisconsin colonies persisting in favorable areas in western, northern and eastern Virginia. There were further reductions in populations during the Holocene xeric interval, leaving many colonies especially in eastern Virginia, and very local colonies of "coastal plain" species in its western region. Beyond all this is the probability of some inordinate disjunctions, between the Middle West and eastern areas, extending back to a pre-Wisconsin migration cycle. These are some of the immense complexities which make this flora so baffling to understand but fascinating to study.

With such a complex of so many elusive populations, scattered hither and thither over the state, we are assured that it will be a fertile land for resolute botanical explorers far into the future.

The Origin, History and Distribution of the "Coastal Plain" Flora

"Coastal plain" flora is a venerable term with a history going back more than 80 years. According to Fernald (1942) true coastal plain species are those growing on the Atlantic and Gulf coastal plains, sometimes with a few remote upland stations. In that paper Fernald also asserts that this flora is very distinctive, giving the coastal plain its individuality.

In spite of the long use of the term "coastal plain" flora, it is doubtful that many botanists have more than a vague idea of the meaning of this concept, but with recent advances in our knowledge of the eastern North American flora, we can now begin to address the origin, history and present distribution of species of this flora, as well as why it is so distinctive.

Since Fernald's heyday a tremendous amount of distributional data have been recorded for the plants of eastern North America, and intensive field work in Virginia, for more than 25 years, is giving us a broad picture of the distribution of vascular plants in the Old Dominion. One of the inland regions rich in "coastal plain" species is the Augusta County area in the Ridge and Valley Province of Virginia (Fig. 1). Botanists now recognize 17 "coastal plain" species in this region:

Carex barrattii, Cyperus dentatus, Eleocharis melanocarpa, E. robbinsii, E. tuberculosa, Lachnanthes caroliniana, Tofieldia racemosa, Glyceria obtusa, Panicum hemitomon, Xyris ambigua, X. jupicai, Sabatia campanulata, Utricularia fibrosa, U. radiata, U. subulata, Polygala cruciata and P. nuttallli.

Futhermore, seeds of *Psilocarya scirpoides*, a very moisture-sensitive species, were found in the 5000 to 4000 B.P. layer in Spring (Hack) Pond (Craig 1969), In addition to the Augusta County area, two other notable concentrations of "coastal plain" plants are on the Cumberland Plateau and in the Great Lakes region and both have been recognized for decades.

In his classic work, *The Plants of Southern New Jersey*, where he used the term "coastal plain" species, Witmer Stone (1911) wrote, "The coastal plain region of New Jersey has always attracted the attention of naturalists because of the striking differences that area presented by its flora and fauna ... Pennsylvanians often liken it to a bit of the Southern States that has been transported northward.… It may seem incongruous to find a southern flora and fauna by going eastward, as we do in this vicinity, but this is easily explained when we examine a map of the life zones of North America." Stone is referring *to Life Zones and Crop Zones of the United States* by C. H. Merriam. Life zones, however, do not explain the occurrences of "coastal plain" species in western Virginia nor the long-known disjunctions on the Cumberland Plateau and in the Great Lakes region.

Palynologists, Pleistocene geologists, paleontologists and field botanists have provided us, in recent years, with historical and distributional data necessary for a better understanding of the origin, history and nature of this intriguing assemblage of plant species. About 23,000 B.P., when glaciers started building and tying up enormous quantities of water, vast areas of unvegetated land became exposed by falling sea levels. At this time plants near the coast must have started migrating to the south, east and north on the newly augmented coastal plain.

In Late Wisconsin a mountain of ice more than 11,000 feet high prevented movement of arctic air masses to the south where oceanic air masses prevailed (Delcourt & Delcourt 1984), and a very moist climate was created by mean temperatures about 7° C lower than today and evaporation about 78 to 80% of that today (Flint 1971).

Paleontologists, particularly those working with ectothermic animals, have made important contributions to our knowledge of Pleistocene climates. Bob H. Slaughter (1975) emphasizes a *warning* to clear our minds completely of the present when postulating climates of the past. Late Pleistocene climates seem to have had cooler summers accompanied by winters lacking cold fronts during glacial stages. This is known as the *climatic equability hypothesis*. According to Holman (1982), this hypothesis was first articulated by Claude W. Hibbard in 1960. Mild winters would explain the southern extralimital animals that Hibbard found in his Pleistocene faunas, and cool summers would explain the extralimital northern animals.

About 10,000 B.P. when glaciers were retreating, the cold Labrador current between the Atlantic coast and the Gulf steam withdrew, and temperate species began to replace the boreal forest in the east. In mid-latitudes of the southeastern states expansion of a mesic deciduous forest occurred within a region of cool-temperate climate and abundant moisture (De1court & Delcourt 1984). The beginnings of westward migrations of "coastal plain" species across Virginia probably date from this time, for in the region of Spring Pond in Augusta County, by 10,000 B.P., a deciduous forest dominated by oak and hickory had replaced the boreal forest (Craig 1969).

Again from Slaughter (1975): "Hester's valuable assemblage of radiocarbon dates associated with extinct animals graphically demonstrates that the great period of extinctions of the Great Plains was approximately 9000 to 8000 B.P." This period approximates the advent of essentially modern (continental) climate, which is much drier and with more extremes of temperatures than the oceanic climate preceding it. No doubt this climatic change brought the elimination of many "coastal plain" plants from interior regions leaving relictual populations in very localized areas, especially on the Cumberland Plateau, the Augusta County area of western Virginia, and the Great Lakes region, but also in scattered sites elsewhere in eastern North America. For example, *Carex seorsa*, a coastal plain – Great Lakes species, thrives in a swamp in Tazewell County and on the

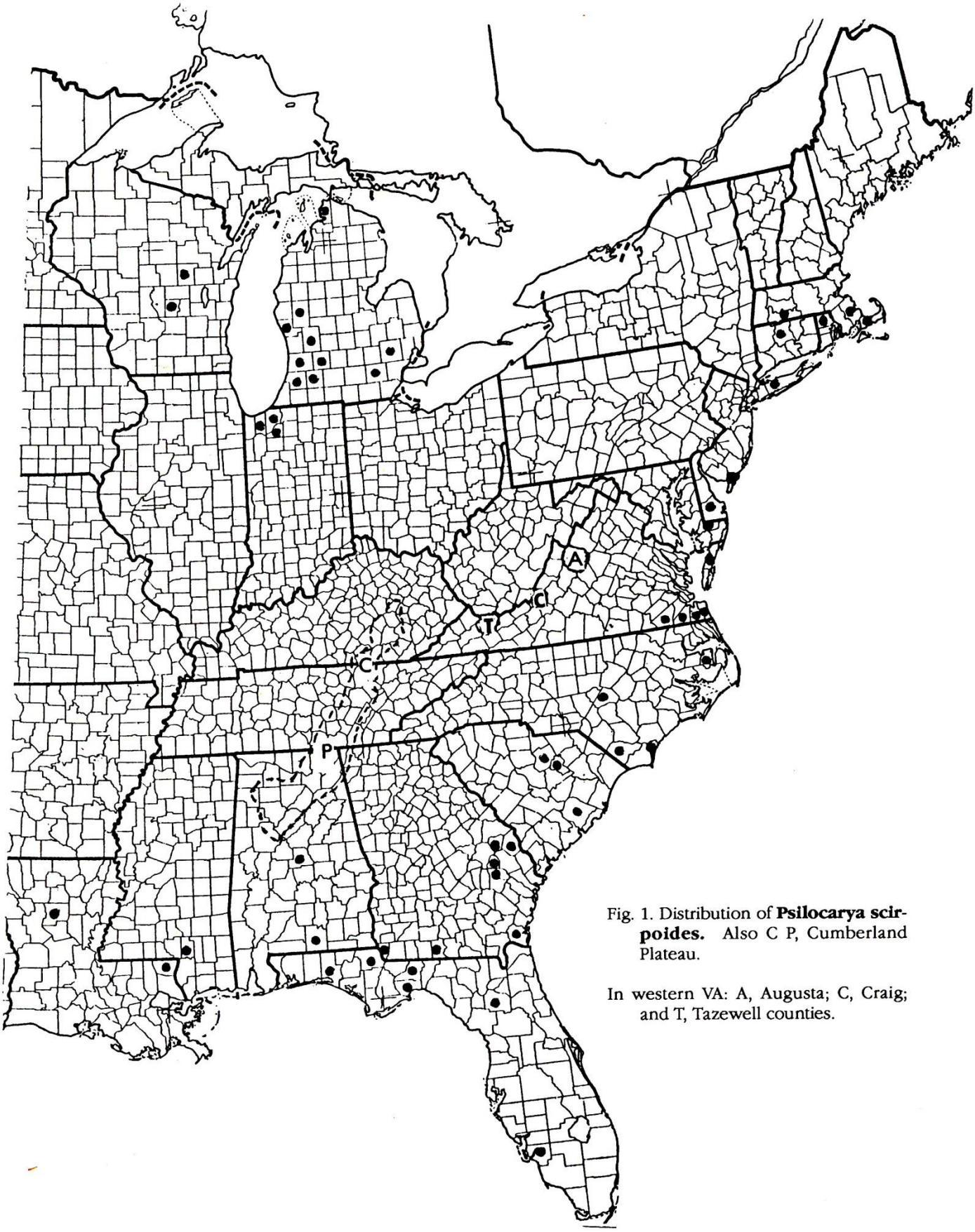

Fig. 1. Distribution of **Psilocarya scirpoides.** Also C P, Cumberland Plateau.

In western VA: A, Augusta; C, Craig; and T, Tazewell counties.

edge of a high-level pond in Craig County, both in far western Virginia (Fig. 1).

To reiterate this history in brief, "coastal plain" species migrated inland after the boreal forest collapsed but while the climate was still oceanic; then most, but not all, populations of these moisture-sensitive species were eliminated from the interior when the climate turned continental, leaving localized relict colonies in areas favorable for their persistence.

Of the 19 species dealt with here, all are definitely southern plants with the bulk of their populations south of the Mason-Dixon line and Stone was correct in his judgment of the coastal plain element in the New Jersey flora. As we can now see, Fernald's view that "coastal plain" species sometimes have a few upland stations falls far short of reality, for fifty years ago details of the distributions of many plants of eastern North America were too poorly known to venture such a statement.

To summarize, the "coastal plain" flora consists of extremely moisture-sensitive species which moved in a broad band into the interior of North America during the succession from boreal to mesic temperate vegetation when the climate was oceanic. Inland from the coast, when the climate changed to continental, most species of this flora were eliminated, but some populations still persist in favorable habitats such as wetland of the Cumberland Plateau; sink-hole ponds, swales, wet meadows, swamps and marshes of Augusta County and vicinity; the Great Lakes region; and in scattered locals elsewhere in eastern North America. This same flora still thrives near the coast, extending in a narrow band from east Texas to New Jersey and beyond.

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A.M.H.