

Three additional characters of *Woodsia obtusa* seem useful for separating it from ferns belonging to the genus *Cystopteris*, namely: (1) the ending of the veins just before reaching the margin of the leaf (in *Cystopteris*, the rule is for the veins to extend to the margin); (2) the presence of scales (on the rootstock and the extreme base of the petioles) with a black or brownish-black center and a tawny margin (all scales in *Cystopteris* are concolorous); (3) the brown color of mature spores which contrast strongly with the very black spores of the *Cystopteris* group.



Fig. 178. To the left, unrolling leaves, and to the right, mature leaves (May 6, 1934), of *Woodsia obtusa*. Note the shape of the mature leaves and also the abundant scales on the petioles.



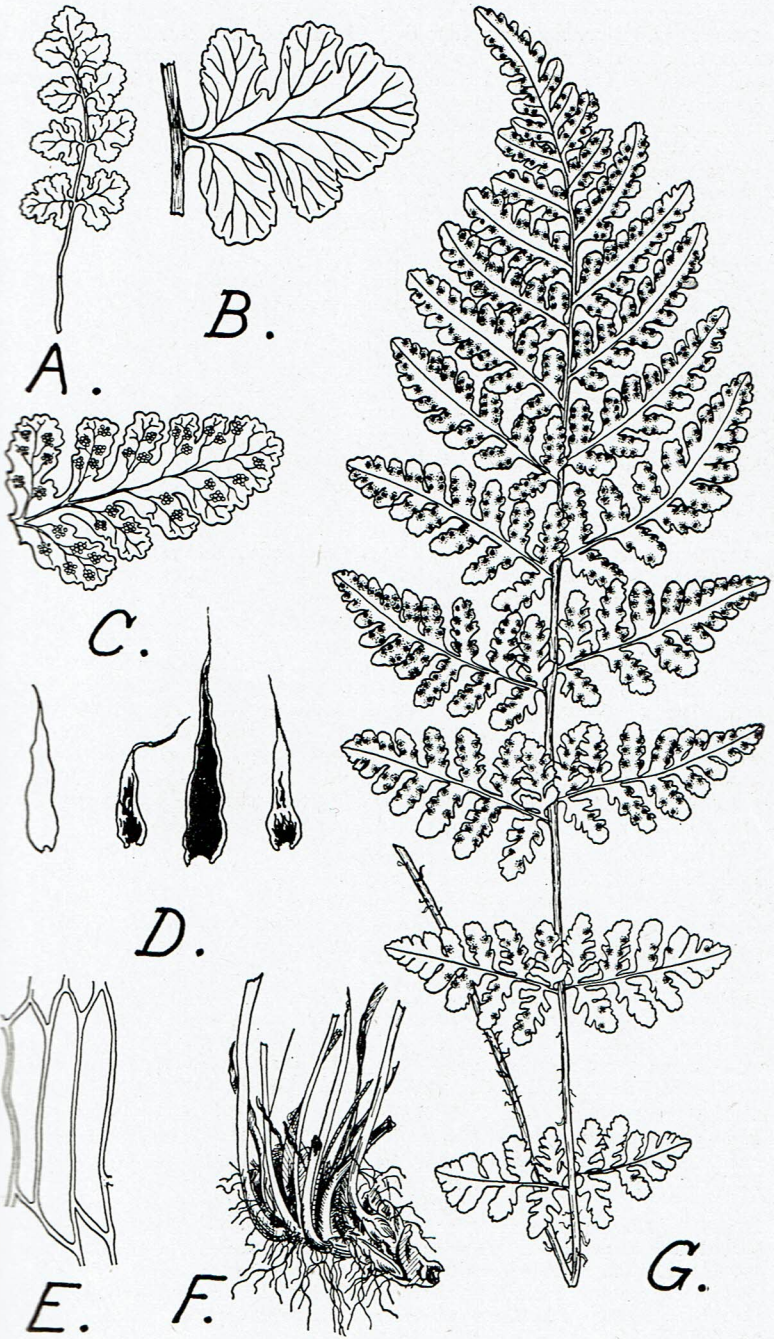
*Description.* *Woodsia obtusa* is a low, tufted, erect, and partly evergreen fern with a short and stubby, vertical, oblique, or sometimes horizontal rootstock (Fig. 179, *F*). The rootstock is about 1-1 1/2 inches long and much branched with each branch bearing a cluster of leaves at or near its apex. Since these branches are close together, the leaves may appear to come from the apex of a single rootstock. The rootstock is about 3/32 to 1/8 inch in diameter, with the older part black or brownish-black in color and the newer part yellowish-brown to light brownish-black. There are a great many black branching roots and many old dead petiole bases. The petioles of the live leaves are near the apex of the rootstock. On the rootstock and on both old and new petiole bases are many scales. Most of the scales, especially those not at the very base of the petioles, are concolorous being golden-yellow, stramineous, or yellowish-brown. On the older rootstock and on the base of the petioles are some scales with a shining, dark-chestnut or black center bounded by a narrow, tawny margin (Fig. 179, *D*). Some scales are very narrow (being almost linear) and long. This type of scale is most plentiful on the upper petiole and on the rachis. Most scales are lanceolate in shape with greatly elongated apices and entire or almost entire margins. Scales are up to about 5/16 inch long and are about 1/50 to 1/40 inch (or even less) in width. The length of the median cells of the scales appears to be about 5 to 8 times the width (Fig. 179, *E*).

The petiole of the leaf is usually not so long as the blade. In our specimens its length varies from 1/2 to 3/4 that of the leaf blades. The petiole may be less than 3 inches in length or as long as 12 inches. Britton and Brown (1936, p. 14) give the length as 3 to 6 inches. In color, the petiole is green or stramineous (sometimes with a reddish tint) except at the extreme base where it fades into brown and then into black. It has many scales which are more abundant at the base. Above is a large groove which disappears near the base of the petiole. The underside of the petiole is cylindrical. Stipitate glands on the petiole and rachis are more or less abundant, varying considerably in abundance from plant to plant. These glands also occur on the leaflets, being scarce on the upper side and plentiful on the lower side. The rachis is very similar to the petiole in shape, color, and the presence of scales and stipitate glands. The presence of scales seems to be the usual rule with Tennessee material, differing in this respect from the description given in Gray's *Manual* (1908, p. 44) ". . . frond never chaffy," but agreeing with Wherry's description (1942, p. 98).

The leaf blade is 5-14 inches long and 2-4 inches wide, thus being a little larger than what Tryon *et al.* (1940, p. 87) give for Wisconsin: 1.5-3 dm. [about 6-12 inches] long and 2-8 cm. [about 3/4-2 3/4 inches] wide. The blade is usually broadly oblanceolate (the commonest shape), elliptical, or lanceolate in shape, acuminate and pinnate-pinnatifid to bipinnate with greatly reduced basal leaflets (Fig. 179, *G*). Leaflets occur in pairs placed almost opposite each other perpendicular to the rachis, and distant from other pairs. In some leaves, most of the leaflets are slightly ascending, those towards the apex being more so. Most leaflets are petiolulate; those above being winged to the rachis, those near the apex being sessile, and those still nearer the apex being reduced to segments. The leaflets are usually narrowly to broadly deltoid to lanceolate in shape with obtuse apices. Some leaves have broadly ovate or elliptical leaflets. Small (1938, p. 315) calls their shape ". . . ovate, triangular-ovate or broadly lanceolate." Some of the larger leaflets of large leaves are pinnate but most leaflets are deeply pinnatifid.

Fig. 179. (Opposite page.) Some details of *Woodsia obtusa*. *A*, A small sterile leaf, once pinnate, with very broad, short leaflets, X 1.0. *B*, A single leaflet from the unusual leaf shown in figures 180, *D*, no. 451, X 2.5. *C*, A broadly lanceolate leaflet such as sometimes occurs in this species, no. 10429, X 2.5. *D*, Scale shapes including some with black centers, X 5.0. *E*, Median cells from representative scales, *F*, Rootstock (with 12 petioles not shown) no. 10437, X 0.8. *G*, A typical leaf, no. 7838, X 1.0.







Pinnules are mostly oblong, obtuse, and winged to the costa. Rarely they are narrowly or broadly lanceolate (Fig. 179, *B*, *C*, and *G*). Commonly, the space or sinus between pinnules is very narrow but occasionally leaves are found (no. 345, for instance) where the pinnules are as far as  $\frac{3}{4}$  ths their

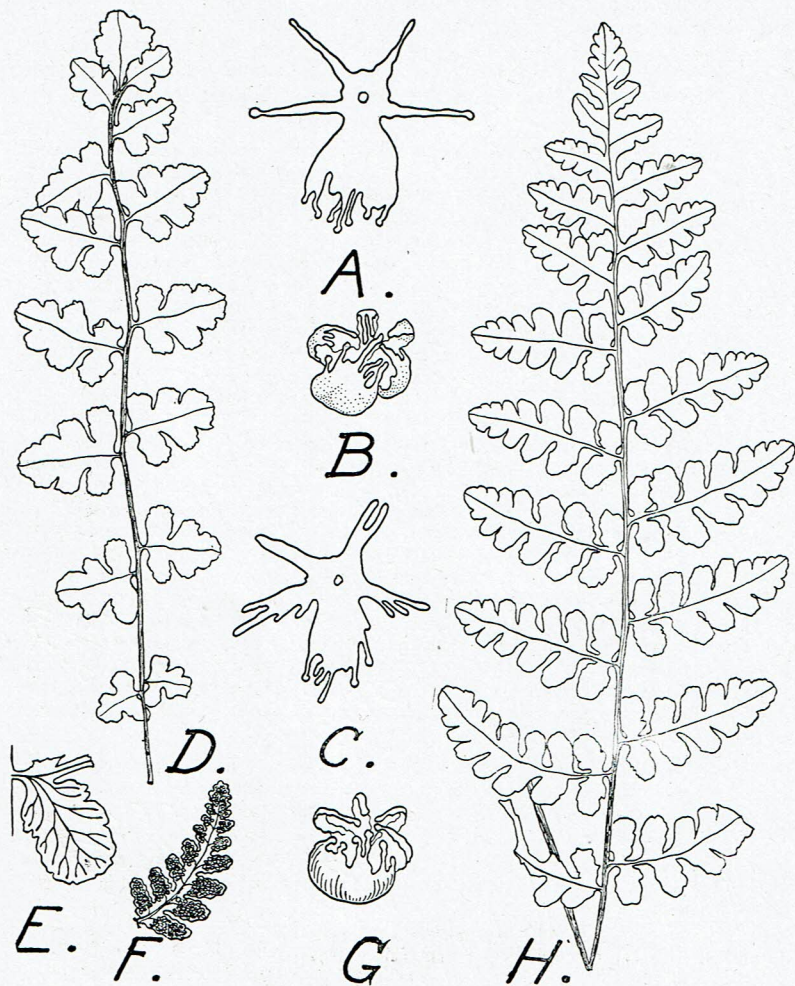


Fig. 180. Some interesting details of *Woodsia obtusa*. *A*, An indusium spread out to show lobes. The circle in the center is the receptacle. The same indusium before having its lobes spread is given in *G*, both drawings from no. 10445, X 20. Note the very large median lobe shown on the lower side. *B* and *C*, Another similar indusium from the same plant showing indusium spread and unspread. *D*, A very narrow leaf with very wide short leaflets, no. 451, X 1.0. *E*, A segment or pinnule from the leaf given in *H*, X 2.5. *F*, A single pinnule showing the occasional coalescence of sori, no. 10437, X 1.0. *H*, A single sterile leaf showing lanceolate and pinnatifid leaflets, no. 450, X 1.0.



diameter apart. This gives the effect of much distance. Some leaves have pinnules with their margins slightly cupped so that they resemble very much the cupped margins of *Cheilanthes lanosa*. Such pinnules often appear acute and their lobes may also appear acute. Larger pinnules are cut into rounded lobes which are themselves cut into rounded teeth. Smaller pinnules may be merely crenately toothed or the teeth may be narrowly oblong and obtuse. Sinuses between teeth or lobes are very narrow. The upper surface of the pinnules is darker green than the lower surface. Oblique veins branch once (usually) or twice and end free in the teeth apparently before reaching the margin.

The sori are placed astride the more apical branch of the vein and nearer the margin than the costule. They are circular and usually separate. In a very few plants, the sori enlarge and coalesce with age (Fig. 180, *F*). Mature sori are from about 1/40 to 1/25 inch in diameter. They may be found with mature spores ready to be shed from early May to late October. Green fertile leaves are very rare during the winter months and when found have their sporangia empty. Most fertile leaves turn yellow and die when winter comes but some green sterile leaves persist all winter. The indusium arises around the receptacle and below the sporangia in an inferior position. It curves over the sporangia and completely covers them at first. Later with the growth and enlargement of the sporangia, the indusium splits into petal-like, greenish or whitish, and membranous segments. In a few Tennessee plants, these segments are like those pictured by Tryon *et al.* (1940, p. 87). Usually, however, our plants have indusia whose segments are very unequal in size; one segment (the median one) being very large and resembling somewhat the indusium of *Cystopteris* (Fig. 180, *A, B, C, G*), the two opposite segments being very small and sometimes so reduced in size as to be almost absent, and the two intermediate segments being intermediate in size. Commonly the free margins of the segments are dissected into very narrow linear lobes some of which appear to be slightly enlarged at their apices. Sometimes small stipitate glands, similar to those found on other parts of the leaf, are seen on the indusium. The indusia, when mature, are a light yellowish-brown in color, very thin and membranous, and seem very delicate but in reality they are relatively permanent structures, not nearly so evanescent as one would suppose. Burnham (1916) mentions the persistent indusia as one of the characters useful in separating this fern from *Cystopteris fragilis* which has very evanescent indusia. Immature indusia are whitish or whitish-green; spores are brown.

Perhaps it would be worth-while to mention some variants from the plants described above. The most common is a plant with small oblong and obtuse leaf blades which are once pinnate. The leaflets are widely ovate, short, and obtuse. They have two or more broadly oblong, obtuse lobes which are crenately toothed (Fig. 179, *A, B*). Leaves like those just mentioned are most often sterile and occur on winter plants but sometimes they may be found in the

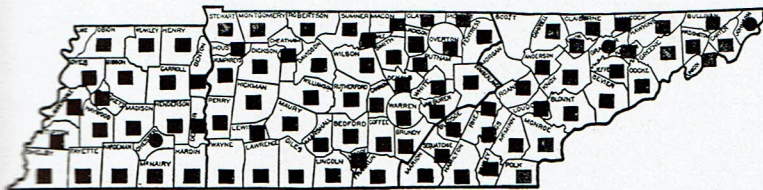


Fig. 181. The county distribution of *Woodsia obtusa* in Tennessee. The black squares represent the collections of Shaver, the blackened circular areas, the collections of others, as follows: Chester Co., J. R. Endsley (Freed-Hardeman College), Grainger Co. (Acad. Nat. Science, Philadelphia), Johnson Co. (Gray Herbarium).



summer. Two other small-leaved plants had sterile leaves like those illustrated in figure 180 (*D* and *H*). The last two variants mentioned above are very rare in Tennessee.

The map (Fig. 181) gives the known distribution of *Woodsia obtusa* in Tennessee by counties, in so far as it is known to the author. The general distribution is given by Broun (1938, p. 166) as "Nova Scotia to eastern Minnesota, south to northern Florida, the elevated parts of the Gulf states, Texas and Arizona. . . ."

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### ALLEGHANY CLIFF-FERN

#### *Woodsia scopulina* D. C. Eaton (variant)

The Alleghany Cliff-fern has fertile and sterile leaves similar in shape and cutting and bears round, distinct sori attached to the free veins on the underside of the fertile leaves. The indusium is inferior in position, being attached under the sorus and almost all around the receptacle. It consists of a small number of petal-like divisions surrounding the sporangia. The above are the most conspicuous characteristics of the two species of *Woodsia* (*W. obtusa* and *W. scopulina*) which have been found in Tennessee. However, these two species may be readily separated by the presence of small, long, septate, white, or sometimes slightly brownish, hairs on the petiole, rachis, and leaf blade of *W. scopulina*, and by the chestnut-colored or reddish petioles in this same species. Both the long hairs and the reddish petioles are absent in *W. obtusa*.

Various authors, including Small (1938, p. 315), have pointed out that the eastern representative of *Woodsia scopulina* seems to differ from the western species in certain ways and Taylor (1947) has even given it a new species name, *Woodsia appalachiana*. He separates this new species from *W. obtusa* by the articulate hairs on the lower surface of the leaves (these hairs are absent in *W. obtusa*) and both *W. appalachiana* and *W. obtusa* from the old *Woodsia scopulina* by indusial characters. The old *W. scopulina* (he says) has indusial segments which are inconspicuous and more or less filiform, while *W. appalachiana* and *W. obtusa* have more prominent indusial segments which are conspicuously broad and wedge-shaped. It should be pointed out that the figure of the indusium of *W. scopulina* given by Britton and Brown (1936, p. 13) shows these segments to be narrowly lanceolate, and that their key on page 12 gives this description ". . . divisions of the indusium . . . mostly concealed beneath the sporanges . . . indusium deeply cleft into narrow flaccid segments." Tryon *et al.* (1940, p. 89) has an illustration (Fig. 131) of an indusium of *W. scopulina* showing rather wide lanceolate or ovate segments with acuminate apices, quite unlike the segments which Small (1938, p. 314) pictures as short, oblong, and obtuse with a fimbriate or lacinate distal margin but describes as ". . . the very narrow lobes spreading." What all of this seems to indicate is that several distinct species, or varieties, or forms, of closely related ferns have inadvertently been grouped together. More studies will be needed in order to determine whether the groups proposed by Taylor (1947) and those by Tryon somewhat later (1948) are valid.

*Woodsia scopulina* is very rare in Tennessee, being known with certainty only from near the Nolichucky River not far from Erwin (Unicoi County) and from a bluff by Beaverdam Creek (exact



locality not given here to save it from destruction) in Johnson County, Tennessee. Probably further search along the streams of



Fig. 182. *Woodsia scopulina* at base of bluff, Beaverdam Creek, Johnson County, Tennessee. Photographed September, 1949.

Fig. 183. (Opposite page.) Details of *Woodsia scopulina*. *A*, Shape and veining of pinnule near base of one of the basal leaflets, no. 369, X 5. *B*, Single leaf, no. 369, X 1. *C*, A very narrow leaflet with short segments and broad sinuses between segments, no. 368, X 2. *D*, pinnule from a median leaflet, no. 369, X 5. The side towards the apex of the leaflet is to the left. *E*, Vertical rootstock largely hidden by the mass of roots, no. 369, X 1. *F*, The type of long, flat, and septate hairs so common on the leaves of this fern, no. 369, X 35. *G*, A very greatly enlarged lobe from a leaflet showing veining, often revolute margin of the leaflet, and indusia with petal-like lobes, no. 10360, X 25. I believe that the artist may have destroyed some of the very small indusial lobes on the midrib side.







eastern Tennessee will discover additional stations. Gattinger (1901, p. 28) gives *Woodsia ilvensis* from Knox County, Tennessee, on the authority of A. Ruth. Despite the fact that Professor Albert Ruth was known as a careful botanist, it seems very unlikely that this species was found in Knox County. Now before *W. scopulina* was well known as a member of the eastern flora, this species was sometimes erroneously identified as *W. ilvensis*, as witness the Old Sweet, West Virginia, station (Maxon, 1919). So a careful search of likely habitats in Knox County seems now indicated as the next step.

*Description.* *Woodsia scopulina* is a small, tufted, rock fern with a very short, black, and vertical rootstock which is usually less than 1/2 inch in length and almost hidden by a great mass of black roots (Fig. 183, E). The leaves arise close together near the apex of the rootstock. At the base of the petioles and on the rootstock are many narrowly lanceolate scales which are characteristically 1/25 to 1/15 inch long and dark chestnut to brownish black at the center with a very narrow tawny border. Each scale ends in a seta which is not long and extended (as is the case in *W. obtusa*). On the petiole some of the scales are wider and broadly lanceolate to ovate in shape. Occasionally each such scale has a small central chestnut stripe, an imperfect chestnut center, or it may even be concolorous (yellowish or stramineous). Very narrow, linear, concolorous scales are sometimes found on the basal one-half of the petiole. Scales are absent or very scarce on the rachis. When present they often occur between the basal and second pairs of leaflets. Tryon (1948) uses the absence of scales on the rachis and on the blade in *W. scopulina* to separate it from related species. This character would not hold for Tennessee *W. scopulina*, for Tennessee material of this species does occasionally have scales on the rachis. This is another small point indicating that the eastern material is not the same as the western *W. scopulina*. Very long (1/15-1/20 inch), small, flat, jointed, white, or slightly brownish, hairs are very abundant on the petiole, the rachis, and the underside of the leaflets (Fig. 183, F). On the upper side of the leaflets, these hairs seem to be less numerous and shorter. Old mature petioles may be almost free of hairs. Often the hairs break off leaving short stubs which may erroneously be interpreted as glands. These short stubs give a mealy appearance to the petiole and rachis at times.

Leaves are mostly erect and tufted with narrowly lanceolate to narrowly elliptical blades and shining chestnut petioles 1-2 1/2 inches long (Fig. 183, B). The bases of the petioles are black in color. Late in the season, petioles may appear longer than they actually are due to the loss of the basal first or first and second pairs of leaflets. Eventually all of the leaflets fall off and leave long upright bare stalks which usually persist into the next season. The petioles are grooved above and are cylindrical below. The rachis in my material has a shining chestnut color at the base of the blade and the brown color seems to extend almost to the apex of the blade where it becomes a duller brown. Rarely, the apical portion of the rachis may be green, the next portion yellowish, the following part a shining bright yellow, then brownish, and finally near the base of the blade the rachis may be chestnut colored. Wherry and Gray (1926) seem to indicate that this sequence of color, which is very unusual in the rachis of Tennessee plants, is the usual thing in West Virginia plants. The blade of the leaf is acute or short acuminate apically and distinctly narrowed at the base as shown so well in Small's picture (1938, p. 314). Most Tennessee leaves have blades 4-6 inches long and 1 1/2 to 2 inches wide. This would make the entire leaf (blade plus petiole) 5 1/2 to 8 inches long. Commonly, the leaflets have petiolules which are so short that the leaflets seem almost to be sessile. More apically the leaflets are winged to the rachis and still nearer the apex they become reduced to broadly attached segments. Most leaflet pairs are relatively close together and may even overlap as Wherry



and Gray (1926) mention. In shape the leaflets are ovate, lanceolate, or oblong, with the oblong shape probably being commonest. They are acute or almost obtuse and pinnate (rarely) or pinnatifid. Wherry and Gray (1926) indicate that West Virginia material sometimes has acuminate leaflets and acuminate leaves but I have found no Tennessee material like this. The pinnules (or segments of the leaflets) are oblong, obtuse, and broadly (rarely narrowly) attached to the costa (Fig. 183, *A* and *D*). The margins of the pinnules are sometimes cupped under and this may make their shape appear to be obovate or oblanceolate and the sinuses larger than usual. The sinuses between the pinnules are most often fairly wide being about  $\frac{3}{4}$  the width of the adjacent pinnules. In some leaves, the sinuses between pinnules are very narrow, while in other leaves the sinuses may be almost twice the width (Fig. 183, *C*) of the adjacent pinnules (no. 386). The larger pinnules are themselves incised into broad, obtuse, and toothed segments; the teeth being rounded and ascending. Oblique veins fork once or twice and end near the margin in the teeth (Fig. 183, *G*).

Sori are usually isolated and are placed astride the veins closer to the margin than to the costule. On some leaves, sori coalesce to make a great mass of sporangia among which indusial segments may be seen (no. 10360). It seems to be the rule for the sorus to consist of a relatively small number of sporangia and for the indusium to remain somewhat cup-shaped. In a few plants where the number of sporangia was great, the indusial segments were flattened out and overgrown by the sporangia. Sori are orbicular in shape and about  $\frac{1}{50}$  to  $\frac{1}{35}$  inch in diameter. The indusium is brown in color, very delicate and membranous in texture. It is inferior in position, being attached to the receptacle under and almost all around the sporangia, and at first arching over and covering them. Later the indusium splits into petal-like segments (Fig. 183, *G*) which seem unlike those pictured by various authors (Small, 1938, p. 314; Britton and Brown, 1936, p. 13; Tryon *et al.*, 1940, p. 89, fig. 131). My own impressions are well given in figure 183, *G*. There may be only one or two segments to the indusium, each irregularly cut. Sometimes there are one or more very small additional segments which may be lanceolate in shape. Mature spores are yellowish-brown in color. Young leaves have on their underside many small capitate glands with short stalks. The petiole and rachis seem free of these glands or they may be very scarce. Small (1938, p. 315) speaks of these glands as having exceedingly long stipes as compared to those of *W. obtusa* but such does not seem to be true of Tennessee material. Mature Tennessee specimens have relatively few stipitate glands, or they may not have any whatever.

The two stations of the Alleghany Cliff-fern in Tennessee have already been given. This fern is also rare in other parts of the eastern United States having been found in a few scattered stations in North Carolina, in Virginia, and in West Virginia.

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