Tenney L. Davis.....	117	26	4.5	35
Carl L. Schmidt.....	117	27	4.3	36
Worth H. Rodebush...	112	26	4.3	36
Henry D. Dakin.....	110	36	3.1	44
Herbert S. Harned.....	109	30	3.6	41
Reynold C. Fuson.....	108	19	5.7	26
Vincent du Vigneaud..	107	16	6.7	19
S. B. Hendricks.....	104	36	2.9	45
Samuel C. Lind.....	104	36	2.9	45
Ralph L. Shriner.....	102	18	5.7	26
Charles P. Smyth.....	101	22	4.6	34

[1]By rank order number is meant the rank according to the average number of papers published per working year as listed in column four.

he remained so.) Further information concerning starred scientists may be obtained from the excellent compilation by Visher (1947). Sampey (1946) has given a list of the number of starred chemists who received their master's degrees and their Ph.D. degrees from each of the several institutions which granted the larger numbers of such degrees. His compilation is also based on the 1944 edition of *American Men of Science*. The few small discrepancies between his table and our table 2 are attributed mainly to our inclusion of chemists who listed chemistry as one of two specialties.

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THE ROYALFERN, THE CINNAMONFERN, AND THE INTERRUPTED-FERN IN TENNESSEE

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Cinnamonfern *(Continued from July number).* It resembles sterile leaves

Fig. 205. (Opposite page.) A single fertile plant of the **cinnamonfern**, Benton County, Tennessee. Photographed in April, 1935.

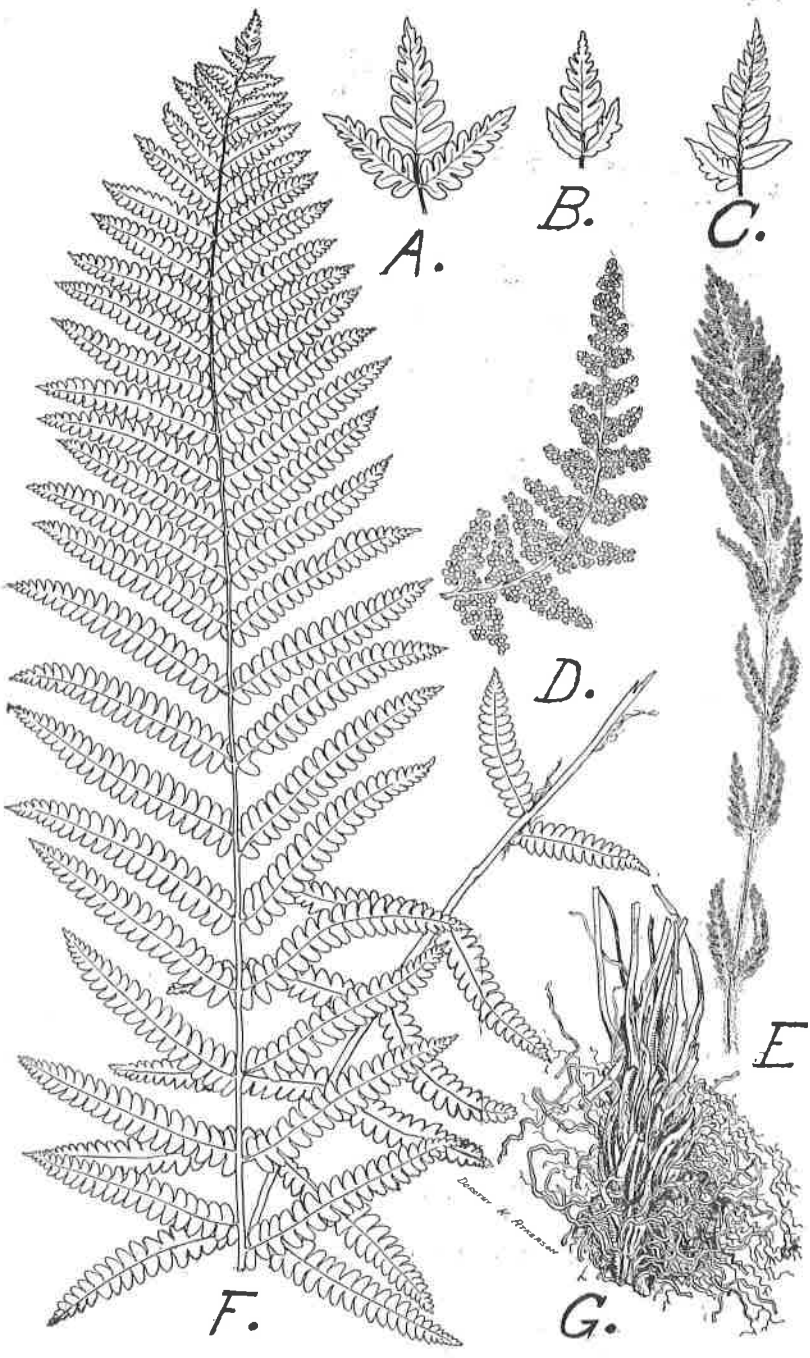
of the cinnamonfern in these particulars, and also in growing in marshes and similar wet places. The Virginia chainfern has petioles that are usually purple and shining throughout, or at least towards the rootstock. Sometimes they are greenish above near the base of the blade. The cinnamonfern petiole is usually green or stramineous except for a very short blackish portion above where it is attached to the rootstock. The leaflets and leaf segments of the chainfern have a row of areoles on each side of the costae and costules. There are no areoles at all in the leaf of the cinnamonfern.

Description. The cinnamonfern is erect, or with arched leaves, about three to four feet tall (rarely up to six feet), deciduous, and clustered. The leaves arise from an erect or suberect thick rootstock which is covered on all sides by the persistent bases of old leaf petioles and by great masses of black branching roots. The rootstock is brown or blackish-brown, about ¼ inch in diameter, and free of scales, hair, and wool (Fig. 206, *G*). The bases of old leaf petioles are black or brownish-black in color (brownish above the brownish-black base), and much flattened with their margins greatly expanded into thin membraneous wings. Recently formed petiole bases and wings are brown or yellowish. Above this portion, the petiole is black to blackish-brown for a very short distance.

Sterile leaves arise from the rootstocks in a circle to the outside of the fertile leaves. Their petioles are usually green or stramineous except for a very small black or brownish-black part at and just above the flattened basal portion described above. Very rarely is the petiole blackish or reddish-brown in color throughout. It is usually reddish-brown just above the blackish-brown basal portion for a very short distance only. In shape, the petiole is cylindrical with a very deep groove on the upper side. Brownish wool occurs in greater or less amounts, especially in this groove. The same type of wool often is found on the rachis of the leaf, on the underside of the costae, and always in the axils of the leaflets. To get some idea of petiole length, 54 petioles were measured and the following results secured: average, about 11½ inches; maximum, 21½ inches (no. 2108); minimum, 5½ inches (no. 4141). The average length is about two thirds the average length of the blades of these same leaves (which is 17½ inches). This would make the longest leaf (blade plus petiole) 50 inches; the shortest leaf 18¼ inches; and the average leaf, 29 inches.

The blade is lanceolate, lanceolate-oblong, lanceolate-elliptic, or elliptic, in shape (Fig. 206, *F*). However, one blade (no. 9709) was oblanceolate. The apex of the blade is acuminate and often abruptly so, the base commonly narrowed, the upper surface dark green, and the lower surface a lighter green. The rachis resembles the petiole in being green or stramineous (rarely reddish) in color and in being grooved above and cylindrical below. Leaflets are usually arranged along the rachis alternately. They may be almost equally spaced or the basal ones more distant. Basal leaflets are often strongly reflexed, those above them being less so, the next ones almost perpendicular to the rachis, and the rest ascending with those nearest the apex being the most strongly ascending. Some leaves have all of their leaflets ascending (no. 2135). All leaflets are distinctly articulated to the rachis. Representative leaves seem to

Fig. 206. (Opposite page.) Details of the cinnamonfern, *Osmunda cinnamomea* L. *A, B, C,* Types of apices present, X 0.4. *A,* no. 2149; *B,* no. 2146; *C,* no. 2143a. *D,* A leaflet showing fertile pinnules bearing great masses of brown sporangia, no. 2910, X 2.0. *E,* The blade of a fertile leaf with much cinnamon wool, many brown sporangia, and leaflets, no. 10233, X 0.4. *F,* Sterile leaf blade, no. 2135, X 0.4. Besides the wool shown on the petiole and at the base of the blade, there are small tufts on the underside in the axils of the leaflets. *G,* Typical vertical rootstock covered with masses of roots and old and new petiole bases, X 0.4, drawn from an unmounted specimen.

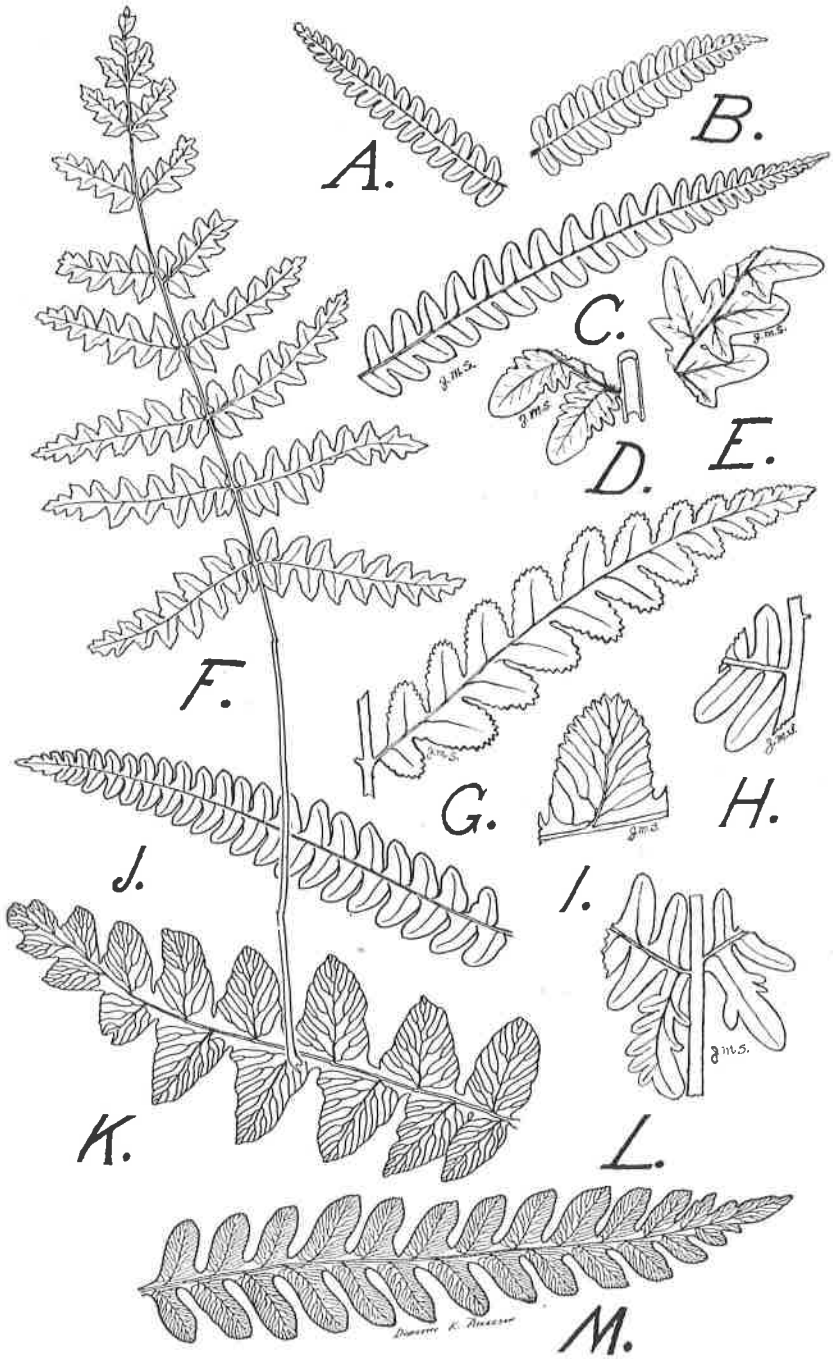

A.
B.
C.
D.
E
F.
G.

have about 30 pairs of leaflets. To get some data on blade sizes, ninety-nine blades were measured as to length and width and the following results secured: (1) length, average about 18 inches, maximum 34½ inches (no. 4421), minimum 7 inches (no. 8072, left plant); (2) width, average about 7½ inches, maximum 11⅝ inches (no. 2110a), minimum 3⅛ inches (no. 10035). Most leaves were widest from one-third to one-half the distance from the base of the blade to its apex. In only a very few cases were the leaves wider nearer the base than this and in only two cases out of the 99 were they wider two-thirds of the way to the apex.

Leaflets are narrow and typically lanceolate to lanceolate-oblong in shape and usually taper rather gradually to an acuminate apex (Fig. 207, *A*, *B*, *J*). Measurements were made of a single leaflet—the longest one—on each of 99 leaves and the following results secured: average about 4 inches long by 25/32 inch wide with a maximum length of 6 inches (no. 2103) and a maximum width of 1⅛ inches (no. 2110). The minimum length was 2 inches (no. 10035) and the minimum width ½ inch (no. 2116). Leaflets are sessile or subsessile and deeply pinnatifid into entire or almost entire, oblong, obtuse or slightly acutish segments which are somewhat inclined towards the leaflet apex. There are generally 18 to 20 pairs of segments per leaflet. These segments on the two sides of the leaflet are about equal in size except on the basal first to third leaflet pairs where the proximal basal segments are much reduced and especially the inferior ones. However, the rest of the leaflets possess well-formed proximal basal segments and have the superior proximal basal segment moved over so as to leave a small gap next to the rachis. A representative segment on the longest leaflet was selected and measured as to length and width on each of 99 leaves. The following results were obtained: (1) length (from costa to segment apex along costule), average about 7/16 inch, maximum 9/16 inch (no. 4141), minimum ¼ inch (no. 2116); (2) width, average about 7/32 inch, maximum 9/32 inch (no. 4410), minimum ⅛ inch (no. 7889, right plant). Inferior and superior segments generally alternate. The rounded sinuses between segments vary greatly in width, from 3/32 inch (Fig. 207, *M*) to a space so narrow that adjacent segments touch or even overlap (Fig. 207, *B*). Margins are entire and sometimes slightly revolute. Oblique veins fork normally only once (Fig. 207, *M*) but occasionally twice-forked veins are found. Vein branches end free at the margin. The wool often found on the costae in the costule axils has already been mentioned. Often hairs of this same type occur on the veins and on the margins of the segments tending to be more plentiful in the sinuses.

Fertile leaves arise in the center of the crown made by the sterile leaves (Fig. 205). They appear in the spring, bear great masses of brown sporangia which almost completely cover the leaflets, and soon wither away. As a rule they do not grow so tall as mature sterile leaves. These fertile leaves grow very erect. The blades are very narrow and have strongly ascending compound leaflets whose pinnules are also strongly ascending (Fig. 206, *E*). Both the petiole and the blade have an abundance of wool. In color the petiole varies from black to brownish-black near the base to green or grayish for the rest of its length. The rachis may also be green or gray. Sometimes, and especially with age, the rachis and the upper part of the petiole may turn black or brownish-black. Leaflets have short petiolules and short pinnules (Fig. 206, *D*).

Fig. 207. (Opposite page.) Details of typical and of unusual forms of the cinnamon-fern. *A*, *B*, *C*, *J*, Leaflets showing shape, segments, and margins. *A*, *B*, X 0.4; *C*, *J*, X 0.8. *A*, *J*, typical leaflets; *B*, leaflet with segments overlapping. *A*, no. 2136; *B*, no. 2143; *J*, no. 2135. *C*, A very slender leaflet, no. 10747. *D*, *E*, *H*, *L*, Portions of leaflets of f. *bipinnatifida*. *D* and *E* are from different parts of the same leaf (*P. J. Adams*, 6/11/1928, Univ. of Tenn.), X 0.8. The upper segment in *E* is similar to f. *trifolia* Clute. *H*, *L*, from the same leaf, no. 10762. *H*, elongated proximal basal segment; *L*, lobed proximal basal segment. *H*, *L*, X 0.8. *F*, *K*, Abnormal leaf and leaflet, no. 2131, with acute triangular segments; *F*, X 0.4; *K*, X 1.2. *G*, *I*, f. *incisa*; *G*, leaflet, X 0.8; *I*, segment, X 1.6. *M*, Leaflet with normal veining and wide sinuses, no. 2132, X 0.8.


A.
B.
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These pinnules bear numerous naked and brown sporangia. There are no indusia. Most sporangia are stalked but some are sessile. Each sporangium seems to be about 1/80 inch in diameter, almost globular, and with a short stalk on one side, or rarely it may be sessile. There is a slightly elevated yellowish area on one side of each sporangium composed of thick-walled cells which opens the sporangium. It is well-developed and probably represent the transverse ring. The sporangium opens through a vertical slit between some very narrow elongated cells in a similar manner to that described for the royalfern. The spores are green.

Osmunda cinnamomea L. forma **incisa** (Huntington) Gilbert

Ferns belonging to this form have toothed or lobed segments with the teeth acute. Only one plant of this type was found. It grew in a wooded swamp near the Sewanee Hospital, Franklin County, Tennessee, and was collected in August, 1943. Each segment is very definitely serrated and the serrations are prominent and acute (Fig. 207, *G*). A branch of each oblique vein seems to enter each serration and to end at the apex of the serration (Fig. 207, *I*). The serrations on the segments of this plant are almost exactly like those shown by Kittredge in her figure 2 (1925, p. 94). The cutting, however, is not nearly so deep as has often been recorded for this form.

Osmunda cinnamomea L. forma **bipinnatifida** Clute

In f. *incisa* the teeth or lobes are acute but in f. *bipinnatifida* they are obtuse. According to Blake (1913, 1914), f. *bipinnatifida* should include Clute's f. *trifolia*. One of the sterile leaves here studied (*P. J. Adams,* 6/11, 1928, Univ. of Tenn.) has some segments definitely f. *trifolia* (Fig. 207, *E*), some other segments *on the same leaf* definitely f. *bipinnatifida* (Fig. 207, *D*), and some other segments normal. In some cases there is only one lobe per segment and this lobe is near the segment base on the rachis side (Fig. 207, *E*). Other segments have two basal lobes, one on each side and are typical f. *trifolia*. These lobes are deltoid-oblong, obtuse, and have unbranched lateral veins arising on each side from a central vein. The more basal pair of leaflets even has some segments near the base with two lobes and some with three lobes on each side of the segment (Fig. 207, *D*). In these cases, the lobes are smaller than where only one or one pair of lobes are present.

A second collection of f. *bipinnatifida* comprising a single plant (no. 10762) from a marshy area on the Cumberland Plateau just northwest of Rockwood, Roane County, Tennessee, was found on September 12, 1951, with at least two leaves (not noted at the time of collection) abnormal in that the inferior basal segment on many of the leaflets is greatly enlarged and partly lobed on at least one side (Fig. 207, *L*). On some other leaflets, the inferior basal segment is elongated but not lobed (Fig. 207, *H*). Such elongated basal segments seem to have most of their oblique veins twice forked instead of the usual once forked condition. In the lobed basal segments, the oblique veins in the lobes are mostly unforked, but the oblique veins in the unlobed portions of such segments are mostly twice forked.

Unnamed Variations

One variation of sufficient importance to be designated a form was found in September, 1940, near highway, U. S. 241, at the top of Iron Mountain, about eight miles west of Mountain City, Johnson County, Tennessee, but it has not been named pending the collection and study of more material. Four leaves were collected and each given a number for future reference (nos. 2128, 2130, 2131, 2160). One has been drawn (Fig. 207, *F*) and this leaf is representative of the lot. All of these leaves are about the same size and shape, being triangular, or almost so. It is the shape of the segments that presents the most unusual feature. The segments are mostly acute and slightly falcate. Their margins are irregularly serrate with most of the serrations minute and inconspicuous. In some segments, especially of leaves nos. 2128 and 2160, there is one prominent tooth on one or both sides near the segment base. Olique veins fork once or twice (Fig. 207, *K*).

A second variation—a minor one—occurred in a plant that seemed normal except that it had very narrow leaflets. A representative leaflet from the collection (no. 10747) is 3½ inches long but only 9/16 inch wide (Fig. 207, *C*). Segments are normally shaped, ¼ inch long, and 3/16 inch wide. It is seen that these segments are *very short*. This specimen was found in a swamp by road 111 about 11 miles south of Spencer, Van Buren County, Tennessee.

The known distribution of the cinnamonfern in Tennessee is given

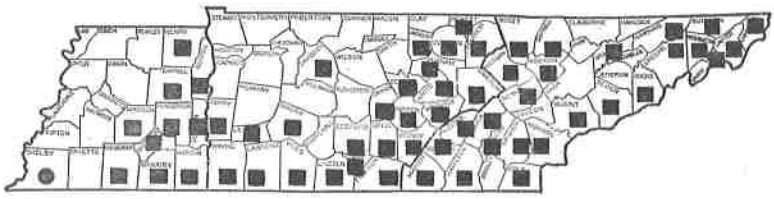

Fig. 208. County distribution of *Osmunda cinnamomea* L. in Tennessee. Shaver's collections are indicated by solid squares; those of others by solid circles as follows: Shelby County (Collected for me by Ralph Sinclair, Shelby Forest).

by counties in the map (Fig. 208). In the country as a whole, it is distributed from Newfoundland to Minnesota, south to central Florida and New Mexico.

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INTERRUPTED-FERN
Osmunda Claytoniana L.

The interrupted-fern is suitably named for an interruption or gap appears in certain of the large leaves. This is due to the location of short fertile leaflets near the middle of the blade. These blades are usually narrowly elliptical in shape and composed of lanceolate-oblong sterile leaflets, pinnatifid into oblong, obtuse segments (Fig. 209). There are about three pairs of sterile leaflets of this type at the base of the blade, then from one to six pairs of small, ascending and contracted fertile leaflets, each of which resembles a diminutive bunch of numerous very small grapes (Fig. 210). Above these fertile leaflets are many lanceolate-oblong sterile leaflets. Such a combination of fertile and sterile leaflets of these types in one leaf is unique among Tennessee ferns and thus will serve, when present, to identify this

fern. Even if the fertile leaflets have become brittle with age and lost, the gap or interruption would still remain.

Unfortunately, however, the majority of the fern plants of this species which are encountered in Tennessee have neither fertile leaflets nor interruptions where fertile leaflets had been. In other words, all leaflets of all leaves are sterile. These sterile leaves of the interrupted-fern resemble very greatly the sterile leaves of the cinnamonfern and the sterile leaves of the Virginia chainfern. Usually, however, entirely sterile leaves of the interrupted-fern can be separated from sterile leaves of the cinnamonfern by the characters already mentioned in the description of the cinnamonfern. Chief among these are two characters: (1) the relative scarcity of wool on petiole, rachis, and in leaflet axils in *Osmunda Claytoniana* as compared with the

Fig. 209. The interrupted-fern, *Osmunda Claytoniana* L., in the Little Marrowbone Creek region, Davidson County, Tennessee. Note the pair of fertile leaflets near the base of the third leaf from the right. Photographed, spring, 1934.

larger amounts present in *Osmunda cinnamomea*. Many authors (Small, 1938; Fernald, 1950; *et al.*) stress the absence of wool in the interrupted-fern as an important identification character. This does not seem to be true of Tennessee specimens for wool is often present on petiole and rachis and nearly always, I believe, in leaflet axils. The important point does not seem to be the presence or absence of wool. Rather, it is the relative abundance of wool, much

usually being present, especially in the leaflet axils, in the cinnamonfern, and a relatively small amount in the interrupted-fern. (2) The relatively abruptly acute leaf apices, the acute though somewhat rounded leaflet apices, and the oblong leaflets in the interrupted-fern usually contrast strongly with the more gradually tapering leaf and leaflet apices, the lanceolate leaflets, and the acute leaflet apices of the cinnamonfern. To this might be added that the leaflets of the interrupted-fern are very thin while those of the cinnamonfern are fairly thick. In general in the field cinnamonfern seems to grow taller, more upright, and less arched than the interrupted-fern. There are cases where the amateur fern student will have difficulty in separating these

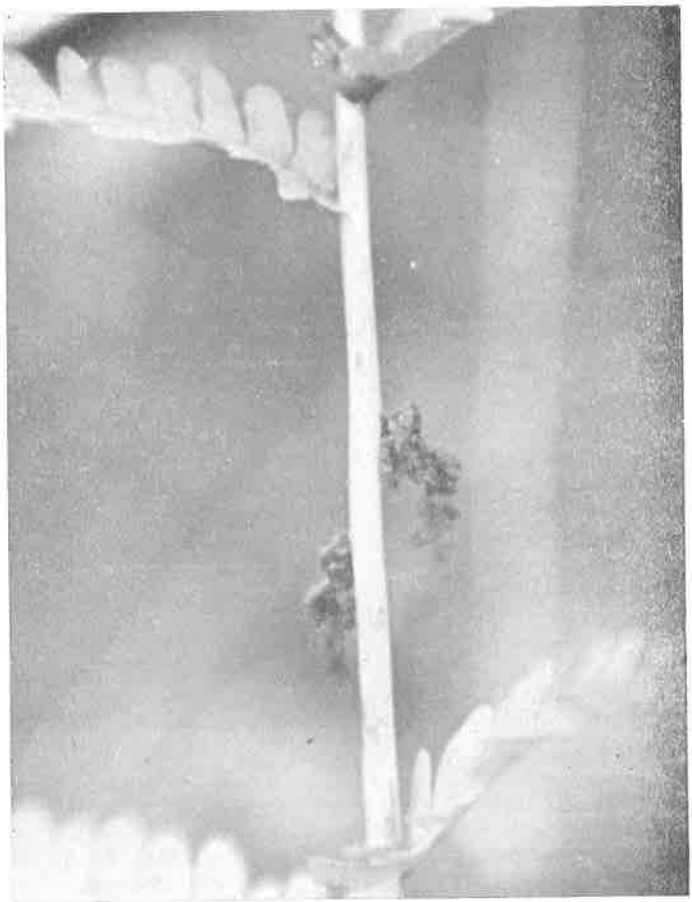
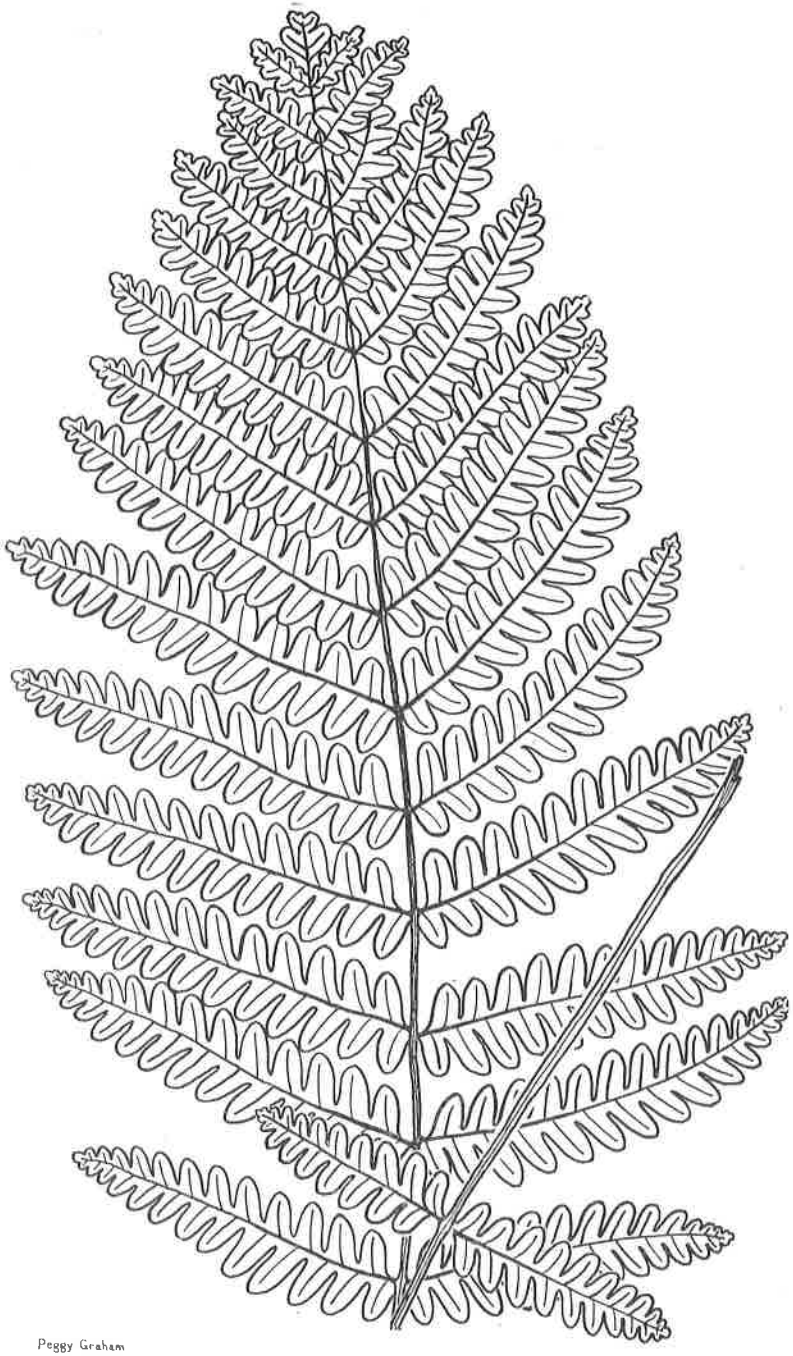


Fig. 210. A portion of the leaf of the interrupted-fern showing one pair of fertile leaflets. Photographed, natural habitat, Davidson County, Tennessee, September 26, 1936.

Fig. 211. (Opposite page.) A single sterile leaf of the interrupted-fern, no. 10729, X 0.5.



Peggy Graham

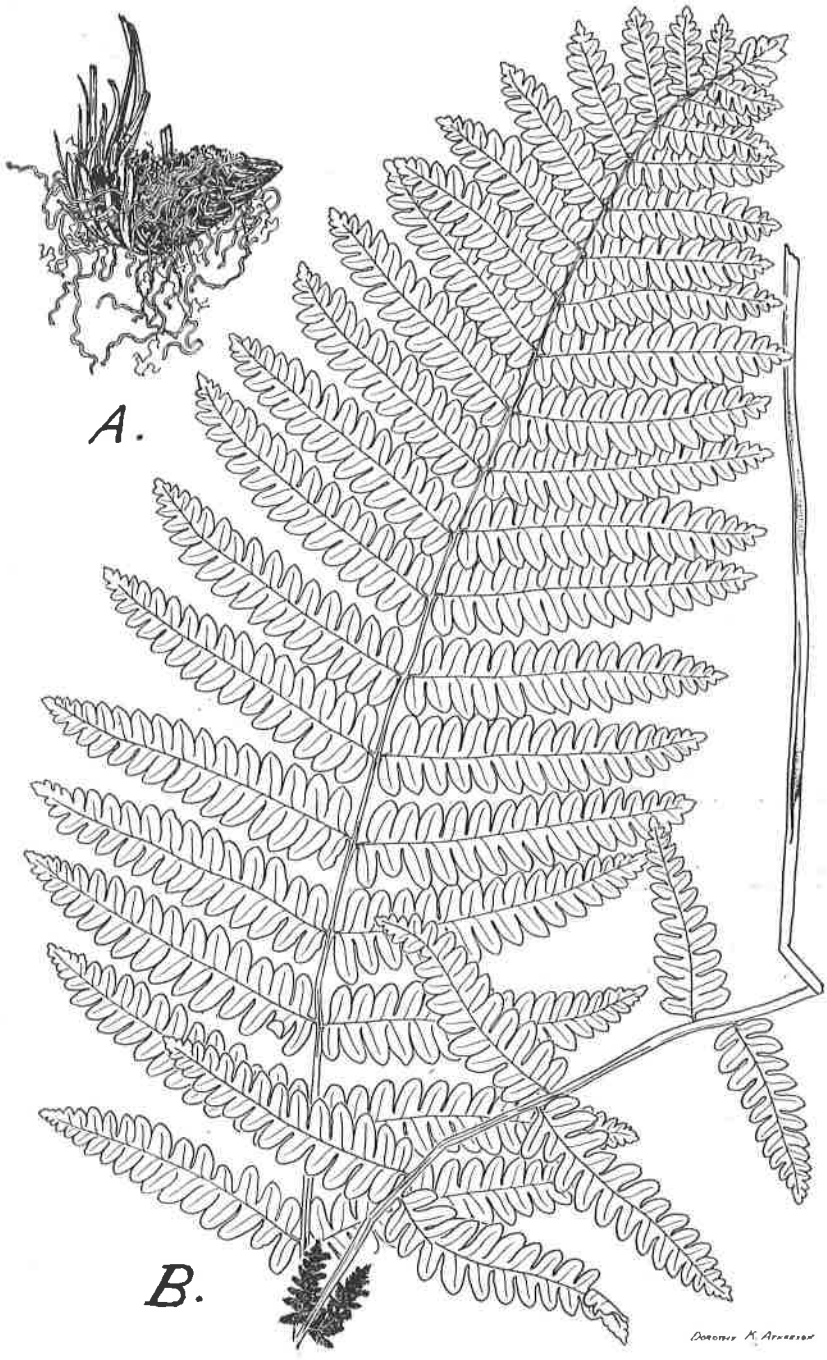
two species for many of the characters used by experienced fern students are minute but important when present in certain combinations difficult to describe clearly. Another fern, the Virginia chainfern, has leaves very similar to those of the interrupted-fern in shape and lobing. However, the Virginia chainfern has a row of areoles on each side of each costa and on each side of each costule, and these are entirely absent in the interrupted-fern.

Description. Osmunda Claytoniana is a tall, semierect or erect fern with broad, deciduous, and arching leaves which arise in large, terminal clusters from an erect or almost erect rootstock. The rootstock is short (Fig. 212, *A*) and gives little evidence of the creeping condition mentioned by many authors. It is densely covered by new and old petiole bases which bear great masses of black or brownish-black roots. These roots appear to arise from the petiole bases as well as from the rootstock itself. However, the petiole bases, which are flattened and broadly and thinly winged, seem to be continuous with the rootstock. Both the rootstock and the petiole bases are brownish-black in color. There are neither hairs nor scales on the rootstock.

The petiole is flattened and winged at the base, as has already been mentioned. This base is black, brownish-black, brownish (probably the most usual color), gray, yellowish, or rarely with a reddish-brown center and whitish-yellow wings (no. 10865e). Just above the winged base, the petiole is black or brownish-black for a short distance (about an inch). Most of the petiole is greenish to stramineous in color or sometimes with a purplish tint or with reddish-brown spots. Mostly-red petioles are rare. In shape, the petiole is cylindrical with a prominent groove on the upper side. The rachis resembles the petiole basally and therefore is green to stramineous in color, cylindrical below, and deeply grooved above. Towards the leaf apex, the rachis may be green or in a few cases purplish. Some few plants have reddish-brown petioles and rachises. The petioles of Tennessee plants have no scales, apparently varying in this respect from Maine specimens which are said (Ogden, 1948, p. 36) to be scaly at the base. The petioles of mature leaves are mostly glabrous except for small clumps of whitish-brown wool which are occasionally held in the groove especially where the sides of the groove are pinched together and for some very short orange or stramineous hairs sometimes present on the upper petiole. Undoubtedly, this wool is a hold-over from the very woolly condition of the petiole, rachis, and the underside of the blade in youth. Judging from the published description of *Osmunda Claytoniana* forma *tomentosa* Neidorf (1949), I don't believe that our Tennessee plants have enough wool to be placed in this form. I have very few entirely complete petioles but I do have twenty sterile and five fertile leaves with petioles broken off in the winged portion or in the black region just above the winged area. These petioles were measured but the measurements are probably about one inch shorter than they ought to be. The twenty sterile leaves had petioles that averaged about 9½ inches in length with extremes of 16 inches (no. 10715) and 6¼ inches (no. 10865). These twenty sterile leaves had blades that averaged about 16¾ inches in length. Thus an average sterile leaf (blade plus petiole) is about 26¼ inches long. The five petioles of the fertile leaves averaged about 14 inches long with extremes of 15½ inches (no. 2044) and 11¼ inches (no. 10084c). The blades of these fertile leaves averaged about 25½ inches long with extremes of 32½ inches (no. 2044) and 16½ inches (no. 10371). Thus an average fertile leaf (blade plus petiole) is about 39½ inches long.

The blades of sterile leaves are variable in shape for when 49 blades were examined and classified as to shape, they fell into nine classes. However, these nine classes might well be combined into three groups: (1) containing the 22 leaves widest near the middle of the blade and therefore narrowly

Fig. 212. (Opposite page.) The interrupted-fern, *Osmunda Claytoniana*. *A*, Rootstock X 0.4. *B*, Fertile leaf, no. 2042, X 0.4, with one pair of fertile leaflets (short and black).


A.
B.
Dorothy K. Atkerson

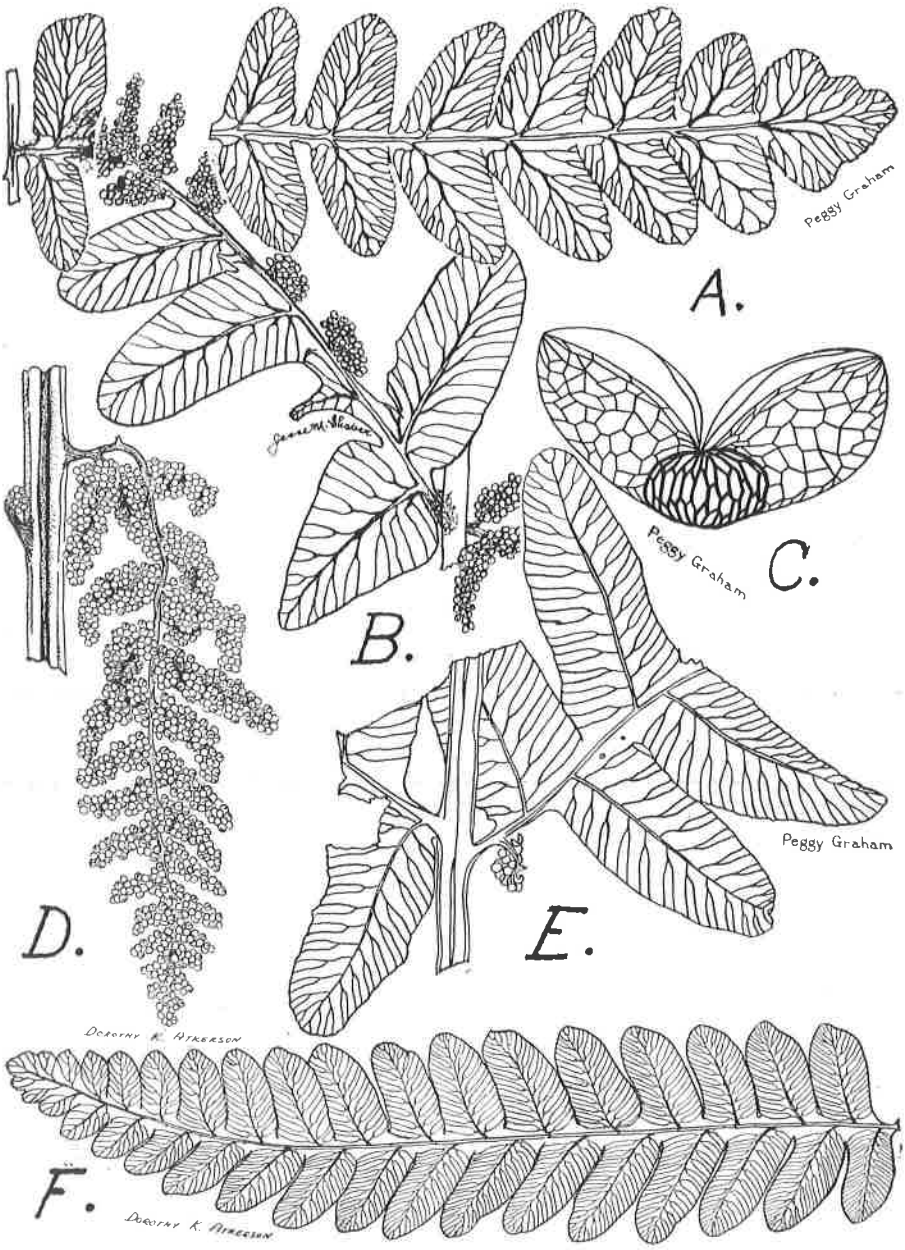
elliptic; (2) containing the 15 leaves widest about ¼ to ⅓ from the base to the apex, thus giving a broadly lanceolate to a narrowly ovate shape; (3) containing the 12 remaining leaves which are oblong or approximately oblong in shape. All blades taper abruptly apically and most blades taper somewhat basally also due to the progressive reduction in size of the basal one to three pairs of leaflets (Fig. 211). The blades are once pinnate into sessile or almost sessile, pinnatifid leaflets which are usually arranged in pairs. Each member of a pair is usually slightly alternately arranged with respect to its mate but sometimes the more basally placed pairs of leaflets have their mates distant from each other. Occasionally the basal one or two pairs of leaflets are slightly reflexed. Often they and the leaflets immediately above them are perpendicular to the rachis. The leaflets towards the apex of the leaf become progressively more and more ascending but never become very greatly so. The number of leaflets per leaf found on 49 leaves ranged from 8 (no. 2026) to 24 (no. 2043) with 16 being the average. The rachis may either be glabrous (which is rare), or possess some wool or hairs. The most common relation is for the wool to be scanty and restricted to the axils of the leaflets; only occasionally being found elsewhere along the rachis and then mostly in the groove. However, the short bases of what appears to be wool often remain in numbers after the wool has been shed. In addition, there are sometimes very short orange to stramineous hairs along the rachis. These hairs are longer, more often present, and more abundant (actually massed in tufts) in leaflet axils. Some few leaves have some leaflets apparently without any tufts of hairs in their axils. Leaflets seem to me to be articulated to the rachis. This view appears to be contrary to that held by some fern students (Tryon, 1940) but many Tennessee specimens show a definite joint here, and other specimens, where their articulation is not so obvious, will often shed their leaflets if the blotters in the press are not changed often when pressing plants in rainy weather. The blade is very thin in texture, dark green above, and a lighter or whiter green below. To get some idea of size, 49 blades were measured as to length and 50 as to width. The following results were secured: average length, about 18½ inches; average width, about 8¼ inches; maximum length, 31 inches (no. 10861c); maximum width, 12 inches (no. 10861b); minimum length, 10¼ inches (no. 10727c); minimum width, 5¼ inches (no. 10727c).

The leaflets of most sterile leaves are oblong in shape and end in a rounded point as Clute (1901) indicated (Fig. 211). Occasionally plants may be found with lanceolate leaflets, some of which are widest at their base and taper gradually to their apices which may be acute. Such leaflets are the exception. To get some idea of leaflet size, the longest leaflet on each of 50 leaves was measured as to length and width and these results secured. Length: average, about 4½ inches; maximum, 6⅛ inches (no. 10861b); minimum, 2⅞ inches (no. 10727b). Width: average, about 1 inch; maximum, 1⅜ inches (no. 10861c); minimum, 13/16 inch (no. 10727c). The leaflets are deeply pinnatifid into segments, as has already been mentioned.

The segments are normally oblong in shape, obtuse apically, and with an entire margin. Rarely the segments are ovate or elliptic in shape or acute apically. This last case seems to be true only when an oblique vein ends at the segment apex and appears to project slightly beyond the margin at the apex. Sometimes, more oblique veins will project slightly to make minute marginal teeth. Exceptionally, a few segments may become greatly reduced in size and such segments may become definitely serrated. The inferior basal segment is close to the rachis and its winged base is even attached to it. The superior basal segment is separated from the rachis by a gap. This

Fig. 213. (Opposite page.) Some details of the interrupted-fern. *A*, Leaflet (basal portion is to the left and separated from the rest) with more branched veins than usual, no. 4116 X 1.0. *B*, Partly fertile and partly sterile leaflet, no. 2031, X 2.0. *C*, An opened sporangium showing near its base a patch of cells making the annulus, no. 2017, X about 150. *D*, Fertile leaflet with many sporangia, no. 2042, X 2.0. *E*, Base of a pair of sterile leaflets with one basal leaflet fertile, no. 2017, X 2.0. *F*, Sterile leaflet, no. 2042, X 0.8. Note shape of segments and veining.

arrangement of superior and inferior basal segment is most marked near the leaf base. It results in most segments being alternately arranged on the costa.



The segments are slightly ascending, especially on the inferior side and near the leaflet apex. In a few cases, they are slightly falcate (no. 10865e). Segments are separated by rounded, or rarely acute, and usually rather narrow sinuses. Where fairly wide, as in no. 10861, the sinuses seem to be widest on the basal pair of leaflets. Some sinuses are extremely narrow (no. 10871, for instance); so much so that some segments may even overlap. In such cases, it seems that it is always the proximal margin, *i. e.*, the margin towards the leaflet base, that overlaps the distal margin of the next adjoining segment basally. Although this overlapping is rare in mature leaves, it seems to always be the condition in young unfolding leaves. Costae and costules of the segments are stramineous, purplish, or rarely reddish. These and to a lesser extent the oblique veins have some hairs on them, as seen from the lower side of the leaf. The hairs are most plentiful in leaflet axils and next in the axils of the costae and then in the axils of the costules. Some are frequently present on the oblique veins on the lower side of the leaf. On the upper side of the leaflet, hairs are absent or very rare. The hairs are of essentially the same structure as the wool, each being multicellular and composed of a row of cells placed end to end. Their color is variable ranging from whitish to reddish-brown. Altogether, 49 large representative segments, a single one from each longest leaflet of each leaf, was measured roughly. The following results were secured as to length: average about 9/16 inch, maximum ¾ inch (no. 2043), minimum 7/16 inch (no. 10727b). The width of the segments was about 5/16 inch on the average with a maximum of ⅜ inch (no. 10840a) and a minimum of 7/32 inch (no. 10865). Oblique veins fork once near the costule with each branch running almost parallel to the other to end free at the segment margin (Fig. 213, *F*). The veins at the base of the segment fork as described above but the lowermost branch occasionally curves upward to join the margin near the base of the sinus between segments. Branches of oblique veins near the segment apex are divergent. Oblique veins near the leaf apex often fork two or more times. The number of pairs of segments in the longest leaflet of each leaf was counted in 48 leaves and these results secured: average 13 pairs, minimum 10 pairs (no. 2026), maximum 17 pairs (no. 2024).

The petiole and rachis of fertile leaves seem to have similar characteristics to those of sterile leaves, which have already been described. Blades, however, differ in that the fertile leaflets, which are short and resemble small bunches of miniature grapes, are grouped together near the middle of the blade where their shortness contrasts with the long adjoining sterile leaflets to make a seeming gap (Fig. 212, *B*). This relationship has already been pointed out. It is repeated here for emphasis. Fertile leaves seem from the literature and from the five nearly complete leaves in my collection to be longer than sterile leaves. The reader will recall that fertile leaves averaged about 39½ inches in length divided between the petiole, 14 inches, and the blade, 25½ inches. Altogether there are 22 well-developed fertile blades in my collection. These have an average length of nearly 27 inches and an average width of about 8½ inches. The maximum length was 37 inches (no. 2039) and maximum width 11⅜ inches (no. 1037b). The minimum length was 13½ inches (no. 2031) and the minimum width 6½ inches (no. 2031).

Fertile leaf blades are narrowly elliptic (rarely elliptic-oblong) in shape and widest above the fertile leaflets, which is usually from ½ to ⅔ the length of the blade. There are usually three pairs of sterile leaflets near the base of the leaf; of 25 leaves, 17 had 3 pairs of sterile leaflets basally; 1 leaf had 3½ pairs; 3 leaves had 4 pairs; 1 leaf had 4½ pairs; 3 leaves had 2½ pairs. The fertile portion usually consists of from one to six pairs of fertile leaflets; of 30 leaves examined, 3 leaves had 1 pair of fertile leaflets; 5 leaves had 2 pairs; 3 leaves had 2½ pairs; 10 leaves had 3 pairs; 1 leaf had 3½ pairs; 5 leaves had 4 pairs; 2 leaves had 6 pairs; 1 leaf had 1½ pairs. Apparently this fern sometimes has many more fertile leaflets than this.

(To Be Continued)