you may understand the framework which ties chemistry to physics to geology to biology, that you may have sufficient contact with science to choose intelligently a field of specialization.

It is our sincere belief that such a broad background in general education will not only make you better citizens but better scientists. It will also make you "three-story men."

THE SENSITIVEFERN IN TENNESSEE

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SENSITIVEFERN

Onoclea sensibilis L.

The sensitivefern is a broad-leaved, coarse, and weedy fern. It is not sensitive in the sense that we speak of the sensitive plant (*Mimosa pudica*) but apparently in the sense of being easily killed by frost in the autumn. *Onoclea sensibilis* has been said (W[eatherby], 1931) to be the oldest living fern, being represented in Eocene time by *Onoclea sensibilis* var. *fossilis* Newberry. This variety differs little in venation and lobing from the *Onoclea sensibilis* of today.

Onoclea sensibilis is a fern of wet places, being found most often at swamp margins, in ditches, near streams, and in similar wet environments. If mature and well-developed plants can be located, identification should be easy for stalks with a terminal panicle of spherical, berry-like bodies grow from the same rootstock as the large, ovate-deltoid, and pinnatifid leaves, and may be found practically throughout the year. During the summer and fall, these berry-like bodies, which are in reality rolled up small pinnules of fertile leaflets, are being formed and are fresh. They overwinter and may even persist in a dead and dried-up condition into the following

summer. The other Tennessee ferns that have somewhat similar fertile structures and pinnatifid or compound leaves, have sterile leaves with the veins ending free (with the exception of *Lorinseria areolata*). Sterile leaves of *Lorinseria areolata* have netted-veined

Fig. 186*B*. The sensitivefern, *Onoclea sensibilis* L., in a wet ravine bottom near Joelton, Davidson County, Tennessee. Photographed on October 13, 1933.

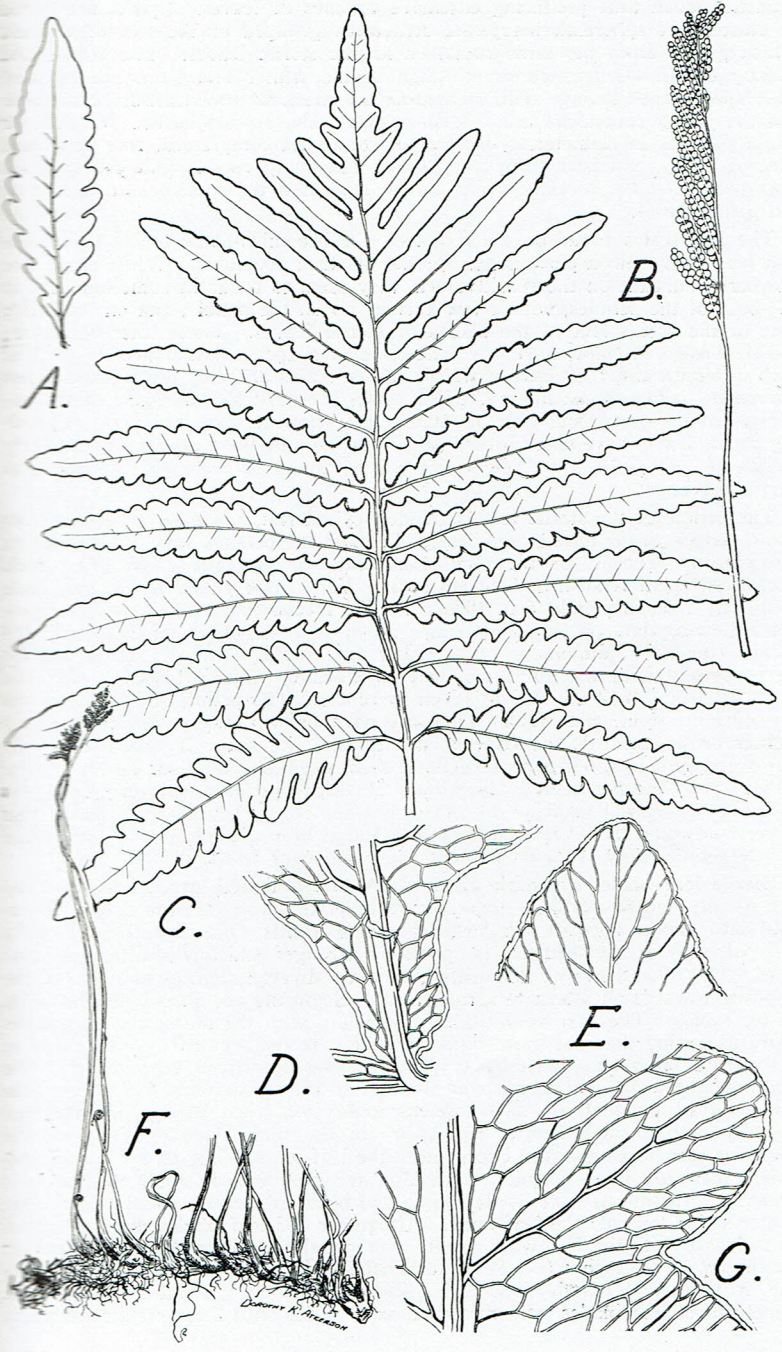
leaves very similar to the netted-veined leaves of *Onoclea sensibilis*. Usually, however, sterile leaves of these two ferns can be separated

by two characters: (1) the opposite or almost opposite leaf segments of *Onoclea sensibilis* as opposed to the alternate segments of *Lorinseria areolata*, and (2) the non-serrate leaf margin of *Onoclea sensibilis* in contrast to the very finely (but definitely) serrated leaf margin of *Lorinseria areolata*.

Description. Onoclea sensibilis, the sensitivefern, is a rather tall fern with deciduous, sterile leaves arising single or in small groups from a slender

Fig. 187. Two fruiting panicles of *Onoclea sensibilis* shown against a background of sterile leaves and other associated vegetation. Swamp margin, north of Portland, Sumner County, Tennessee, Oct., 1950.

Fig. 188. (Opposite page.) Some details of the sensitivefern. *A*, A rather wide and short basal segment, no. 7859. X .4. *B*, A fertile leaf showing the arrangement of the berry-like structures in the panicle, no 510b, X .4. *C*, A representative sterile leaf blade, no 8226, X .4. *D, E, G*. Portions of a leaf segment selected to show veining and the relative size of the areolae, no 8226, X 4.0. *D*, Segment base with a single scale. *E*, Segment apex, *G*, A small portion about midway of the segment. Note marginal endings of veins (not shown correctly in *D*) and the marginal rim. *F*, Rootstock bearing some uncoiling leaves, two of which are fertile, no. 8103, X .4.


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

(Wherry, 1942, page 95, says "rather stout"), and horizontal rootstock which branches much thus producing extensive colonies of leaves. Spores are borne in clusters of spherical, berry-like structures grouped at the end of a stalk which grows from the same rootstock as the sterile leaves. The fertile and greatly modified leaves persist throughout the winter and seem not to shed their spores until spring. Old rootstocks are black or brownish-black in color but the young rootstocks are reddish-brown. The rootstocks are 1/8 inch or slightly larger in diameter, cylindrical or somewhat compressed, free or almost free of scales, and bear many very small, branching roots. Old petiole bases may persist on the rootstocks for a time but often the rootstocks are free of old petiole bases.

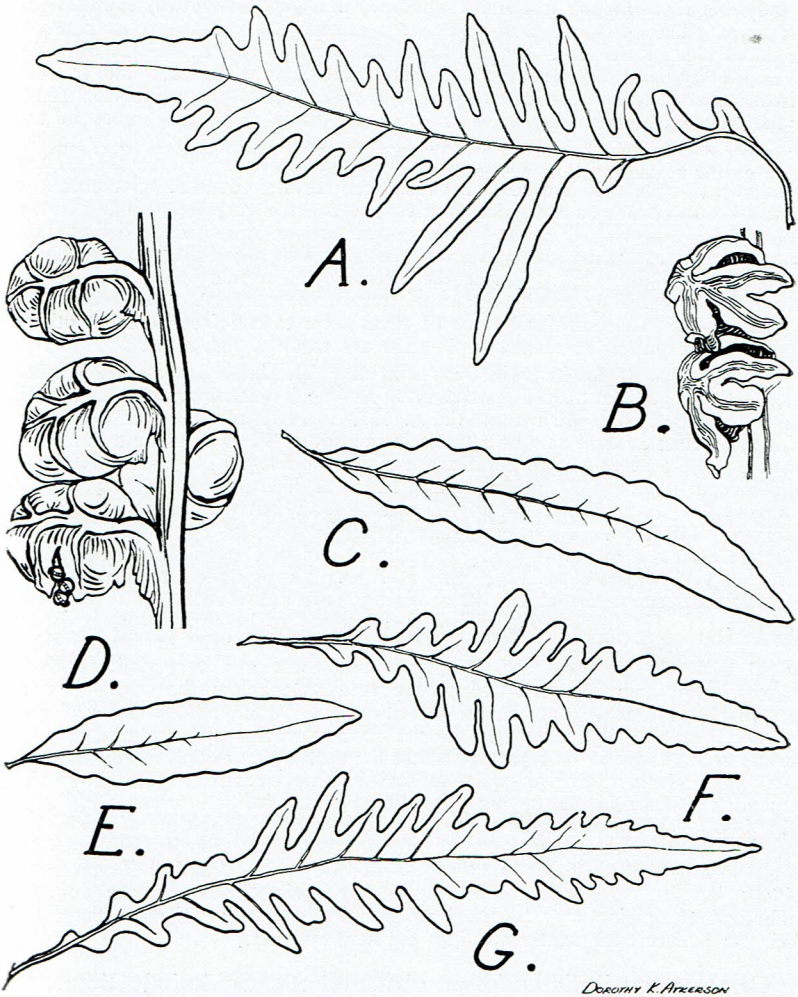
The few scales found on the rootstock are brownish-black to black in color and hence very inconspicuous against the blackish rootstock. While scales are nowhere abundant on the sensitivefern, they seem to occur in some numbers at the base of the petioles, with a few farther up on the petiole, and on the under side of the rachis and of the blades of sterile leaves. These later scales are mostly brown in color, narrowly lanceolate in shape, and measure up to 3/32 inch in length and 1/40 inch in width. Some scales are very much smaller and narrower (being almost linear). Such scales are most characteristic of the underside of the costae and veins of sterile leaf segments (see no. 525). Uncoiling sterile leaves have many brown scales but most of these apparently are early fugaceous. Occasionally a few scales will be found on the rachis or costae of fertile leaves.

The petiole of the sterile leaf is slender, cylindrical, and grooved above from the rootstock to the base of the blade. In color the petioles vary from green to stramineous (except for the very short black or blackish-brown base) with occasional small reddish or blackish spots. Very small young leaves may have a slightly reddish petiole (no. 10262a). The measurement of 36 petioles gave the following data on length: average, about 14 1/4 inches; maximum, 27 1/4 inches (no. 527); minimum, 4 7/8 inches (no. 10252, bottom). These lengths agree closely with the 10-65 cm. lengths given by Ogden (1948, p. 92) but seem much less than the lengths given by others. The petioles of fertile leaves are upright, stout, and rigid. They are dark brown basally and fade into a lighter brown towards the fruiting structures. The shape is cylindrical without a groove. In the field these petioles seem much shorter than sterile petioles (Fig. 187), but the average length of 14 fertile petioles was only 13.8 plus inches as compared to about 14 1/4 inches for sterile petioles. Doubtless this difference would have been much greater had it been possible to have measured sterile petioles only from those plants that also bore fertile leaves.

Sterile leaf blades are dark green above and a lighter green below. They are usually deltoid-ovate in shape with acuminate apices and are deeply pinnatifid into almost opposite narrow to broad segments (Fig. 188, *C*). Usually one pair only of the segments is oppositely arranged and this is often the basal pair. The other pairs of segments commonly diverge slightly more from the opposite towards an alternate arrangement. Segments are almost perpendicular to the rachis. They are very slightly ascending with the more apical segments more ascending than the basal ones. In one case the segments were falcate in a basal direction (no. 503). The rachis is winged between segments with the width of the wings increasing from the base to the apex of the leaf. From the underside of the leaf, the rachis seems to be cylindrical basally and flattened apically with a small central ridge. From the upper side of the leaf, the rachis is seen to be grooved except near the leaf apex. The larger costae and, where there are large costules, these also, are grooved. In color the rachis is green or stramineous near the leaf base and brownish with a small stramineous center stripe towards the leaf apex. Altogether 102 leaf blades were measured as to length with the following result: average, slightly more than 9 1/2 inches; maximum, 19 3/8 inches (no. 510); minimum, 4 1/2 inches (no. 512). This makes the average total length of a leaf (petiole plus blade) about 23 3/4 inches. Ninety-three leaf blades were measured as to width with these results: average,

slightly more than 9 1/2 inches (about the same as the average length); maximum, 17 1/4 inches (no. 525); minimum, 5 3/8 inches (no. 512). Usually the greatest width is at the base of the blade. This was the case in 52 out of 93 leaf blades. The rest of these leaf blades had their greatest widths as follows: 30 at the second pair of segments, 9 at the third pair of segments, and 2 at the fourth pair of segments.

The basal leaf segments are usually narrowly elliptical to narrowly oblong. The other segments become progressively narrower and more oblong in shape from the base to the apex of the leaf. The basal segments often taper at each end but the other segments are seen to be narrowed basally less and less as one



. 189. Additional details of the sensitivefern. *A, C, E, F, G,* Basal segments from many leaves as follows: *A,* no. 510b; *C,* no. 10573; *E,* no. 9170; *F,* no. 9806; *G,* no. 52[3]b: all X .5. *B,* Two berries showing manner of dehiscence, fresh material, X 2.5. *D,* Berries showing veins, no. 510b X 5.

glances from near the base to the apex of the blades. Segment apices are acuminate, acute, or obtuse. The margins of the basal segments vary greatly from plant to plant. In general, small plants have entire, undulate, crenate, or small rounded-toothed margins to their segments, while the larger plants may have very large, irregular, rounded teeth on their basal segments. Figure 189, *A, C, E, F, G,* is of a series of basal segments selected as representative of the types of margins present. One basal segment from each of 94 leaves was measured for length and greatest width with the following results: average length, 5 1/2 plus inches; average width, 1 1/8 plus inches; maximum length, 10 1/8 inches (no. 525); maximum width, 3 5/8 inches (no. 510); minimum length, 2 3/4 inches (no. 519); minimum width, 1/2 inch (no. 519). The margins of the other segments are less and less toothed in a progressive way towards the leaf apex. The costae of well-developed segments are cylindrical as seen on the under side of the leaf. On the upper side of the leaf, the costae of well-developed segments are grooved and may have a very delicate and narrow raised lateral wing. The veins anastomose to make a great many areolae. Next to the rachis on each side, there is often a greatly elongated areola in the wing. It is formed by a vein extending from one costa (or very near it) to the next costa. There is a similar greatly elongated areola on each side of the costa in well-developed segments between well-formed costules. Sometimes a similar areola occurs on each side of a costule in each very long tooth of very large leaf segments. The other areolae are not so long. They decrease in size towards the segment margin and have their long axes placed at an angle to the costules or costae. Under the microscope the margin of the leaf is seen to be bordered by a delicate rim of translucent material. The veins seem to run into this substance and some of them seem to end free here but others seem to course in this substance to close the areola (Fig. 188, *D, E, G*).

Fertile leaves do not look like leaves at all. The blade is compound being formed of a panicle of stiff, strongly ascending branches bearing spherical, sessile, and berry-like structures (Figs. 187, 188, *B*) arranged in two rows with the berries in each row bent towards each other so as to make a one-sided branch. These berry-like structures are slightly oblong. They measure about 5/32 inch in length, 4/32 inch in width, and 2/32 inch in depth. They have a few very long linear white and appressed scales. When mature the berries are black or almost so. Each berry-like structure consists of a leaf segment wrapped around a group of sori. The costule and three to six pairs of lateral veins are very conspiculous (Fig. 189, *D*). Occasionally the lateral veins fork once. Each vein seems to end in a slightly enlarged foveola. The roundish sori occur within the berries. Each sorus seems to be attached to a raised receptacle somewhere near the middle of each lateral vein or branch of a lateral vein. While immature, it appears that there is a very delicate membranous white indusium attached to the receptacle below the sorus (Faxon says that it is attached only on the inferior side—Eaton, 1886) and covering it entirely in a hood-like manner. As the sorus develops and matures, the indusium seems to break or separate so that the sporangia are only partly covered. Later the indusia disappear and the sori become confluent. The berry-like structures dehisce in the spring (I believe) by splitting between the lateral veins into lanceolate to elliptic segments (Fig. 189, *B*). The time of dehiscence does not seem to be well understood by many botanists. Small (1938, p. 323) states—erroneously, I think—that spores mature in the fall but Tryon *et al.* (1940) has it ". . . spores maturing in the spring." The reason for this difference of opinion may be the long growing season for fertile leaves and their persistence over winter and into the next summer.

Onoclea sensibilis L. forma **obtusilobata** (Schkuhr) Gilbert

This form (forma *obtusilobata*) of the sentitivefern is included here on the basis of its report from Williamson County, Tennessee, by Gattinger (1887, 1901). It ought to occur occasionally at other

places in the state. It seems that the sterile leaves of this form are intermediate between normal fertile and normal sterile leaves in that their primary segments have small, rounded, and flat secondary segments or teeth which sometimes have occasional sori present. Accompanying the reduction in the size of the segments is a reduction in the number of areolae present so that most of the veins end free without forming areoles at all. Some authors have claimed that this form is produced by mutilation and starvation, and especially by grazing and mowing (see Atkinson, 1911, for successful experiments along this line). However, Poyser (1909) failed entirely to secure results of this type and Davenport (1881) pointed out that leaves of the *obtusilobata* form occur where no mutilation or starvation took place and in company with normal sterile and normal fertile leaves. He further states that when plants are mowed, the majority of the leaves appearing later are normal leaves with only a few, if any, *obtusilobata* leaves. Weatherby (1917) regards forma *obtusilobata* as a teratological form. He presents a plate showing a series of leaves intermediate between normal and the *obtusilobata* types. Interested readers ought to see the halftone illustration (Fig. 107, p. 74) of three leaves by Tryon *et al.* (1940) and the colored plate of this form in Eaton (1886).

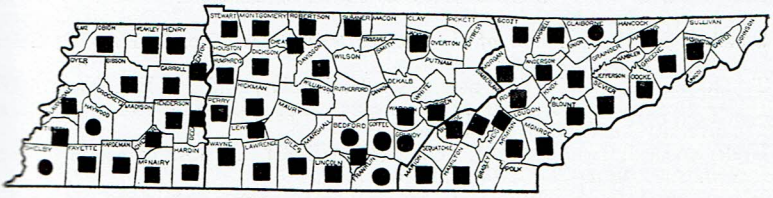


Fig. 190. The county distribution of the sensitivefern in Tennesse Blackened squares, the collections of the author; blackened circles, the collections of others as follows: Coffee, Grundy, and Haywood counties (Univ. of Tenn. Herbarium); Bedford County (Anderson, 1930); Franklin County (I have a specimen collected by Dr. J. T. McGill near Sewanee, 1881); Shelby County (Mr. Ralph Sinclair, Park Naturalist, collected a specimen for me from Shelby Forest).

The county distribution of *Onoclea sensibilis,* in so far as known to the author, is given in figure 190. Broun (1938, p. 121) gives the general distribution of the species as from "Newfoundland to Saskatchwan, south to northern Florida and Texas . . ." The form *obtusilobata* in Tennessee has only been found in Williamson County but may be expected in other counties.

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NEWS OF TENNESSEE SCIENCE

(Continued from page 116)

Dr. Goodpasture will make a study of the effects of bomb radiation as exhibited five years after exposure, on the children born of Hiroshima and Nagasaki survivors.

Mr. Roy Morton, Health Physics Division, ORNL, addressed the thirtieth annual conference of state sanitary engineers, on "Waste disposal problems of Oak Ridge of interest to sanitary engineers."

Recent Publications by Tennessee Authors

Birkhoff, Robert D. (Univ. of Tenn.). 1950. Civilian defense against the atomic bomb. *Tenn. Indus. Hygiene News,* 7 (4) : 6-9. 14. Oct.

(Continued on page 156)