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HAIRS AND GLANDULAR HAIRS OF PLANTS, THEIR FORMS AND USES.

BY PROF. W. J. BEAL.

COMMON in green-houses is a plant called *Ageratum mexicanum*, which is grown chiefly for its light-blue heads of flowers which are valuable for bouquets. The stems and framework of the leaves are slightly rough on account of large numbers of hair-like projections along the entire surface. A small fragment placed under a moderate magnifying power reveals the structure of these beautiful and delicate objects as follows:

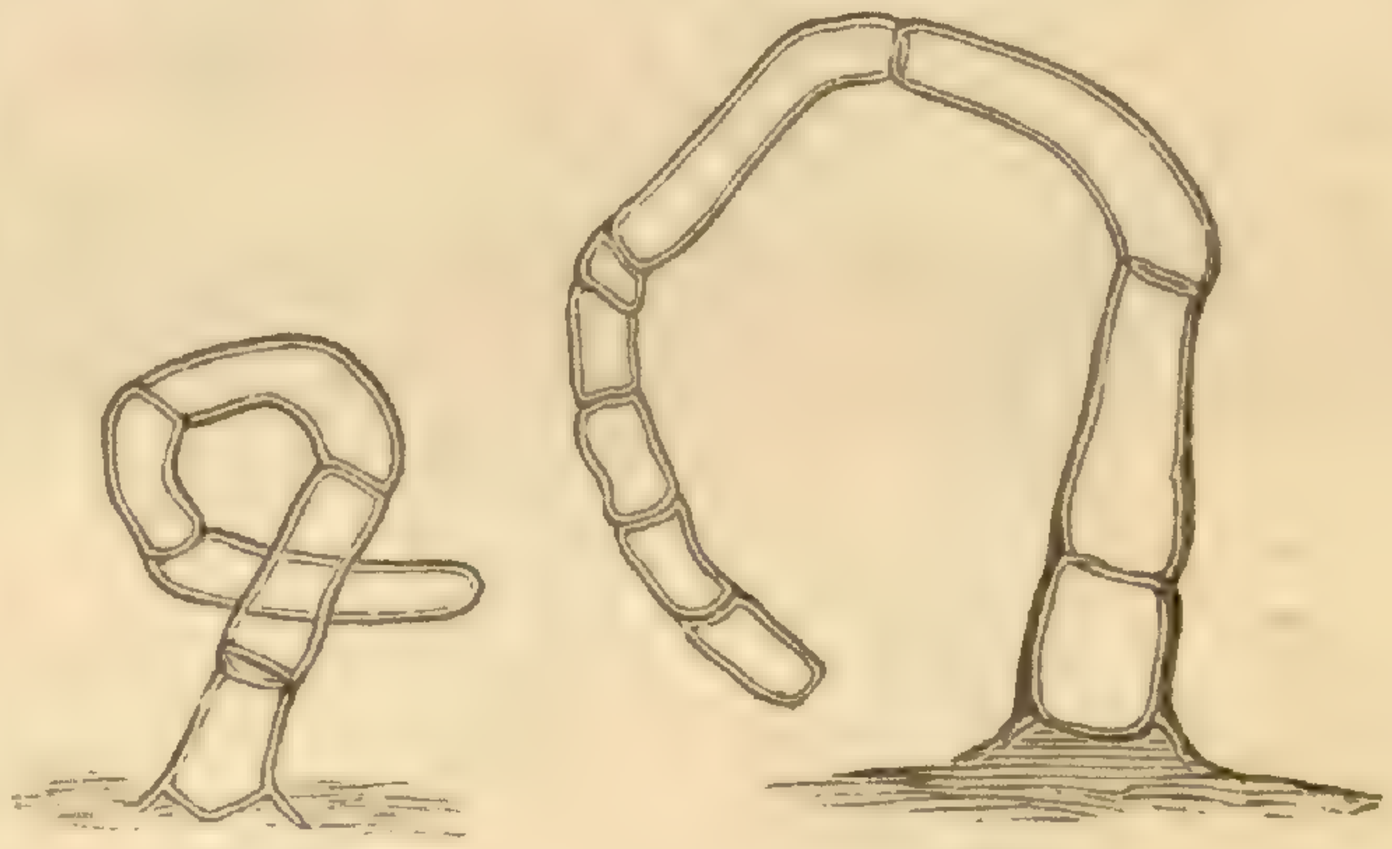

FIG. 2. FIG. 1.

Curved hairs on *Ageratum mexicanum*.[1]

The greater number of these consists of from five to twenty cells of different sizes and lengths placed end to end. Each hair or chain of cells is curved more or less, often into a complete ring, always towards the top of the plant. The end cell is blunt or rounded at the tip. Scattered among these are occasionally seen sharp-pointed hairs which are straight and much more slender. Still less frequently may be seen larger and stouter projections, like Fig. 4, in which there are two rows of

[1] The degree to which these figures are magnified is not given because of considerable uncertainty in most cases. The objects were all drawn by Mr. W. S. Holdsworth, a student in Michigan Agricultural College, generally without the use of a camera. A Wales one-fifth objective, and a B eye-piece were the highest powers used in any case.

cells overlapping each other. The lower cells are three or four times as long as broad, while towards the top the transverse diameter is the greater. The top of the projection is capped with a single hemispherical cell which is filled with a mucilaginous substance. All the other cells are in a greater or less degree transparent. They are filled with a liquid containing granules which under a magnifying power of 250 diameters are often seen to move about in steady flowing currents. Some of these glandular hairs, like Fig. 5, have but a single row of cells for the main portion of their length. Perhaps still other

FIG. 3. FIG. 4.

FIG. 3. — Slender hair of *Ageratum mexicanum.*

FIG. 4. — Glandular hairs having two rows of cells.

FIG. 5.
Hair of *Ageratum.*

FIG. 6.
Hair of *Erigeron canadense.*

FIG. 7.
Stout one-celled hair on *Panicum capillare.*

forms might be found which would be intermediate between some of these, showing more conclusively that they were modified forms of the same members.

Erigeron canadense, a common weed often known as horse-weed or mare's tail, is clothed all over its surface with slender rapidly

tapering hairs composed of a single row of cells. Many species of *Helianthus* are covered with similar hairs. The surface of *Panicum capillare*, old witch grass, is covered with slender, one-celled hairs which are straight and quite stiff for their size. The surface of a common *Physalis*, or ground cherry, abounds in slender hairs composed of from ten to fifteen cells placed in a single row. Some of these hairs terminate in a sharp point, but most of them have, at the end, a round cell like a knob, full of a sticky substance. Occasionally a hair produces one or more branches which may likewise terminate with a short point or a globular cell.

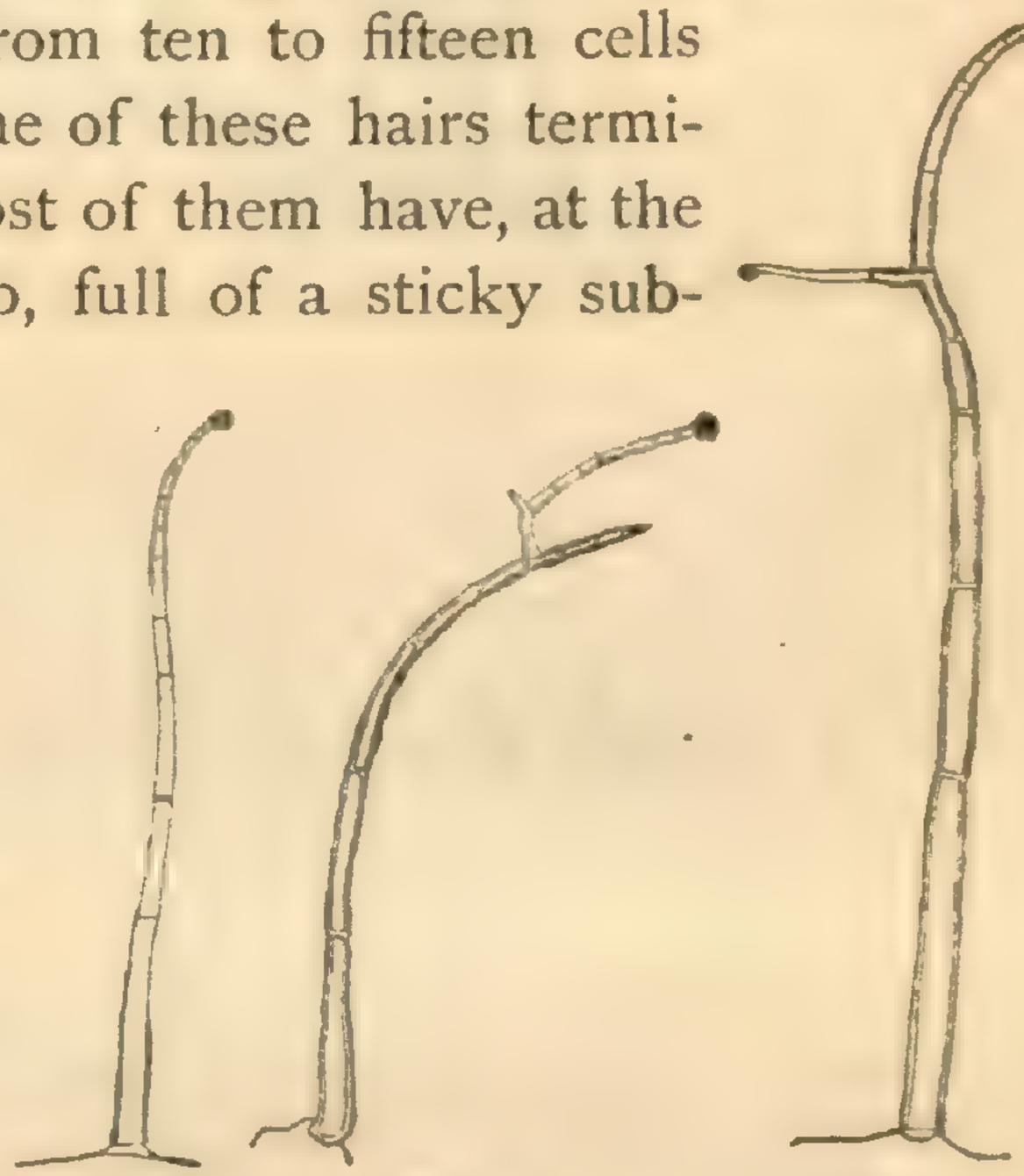

FIG. 8. FIG. 9. FIG. 10.
Hairs on surface of *Physalis*, ground cherry.

The fruit of *Circæa lutetiana*, enchanter's nightshade, is covered with rather stout one-celled hairs which have a hook at the extremity. The stems of the common butter bean of our gardens have a few scattering hairs of similar structure, though they are smaller and much more delicate.

FIG. 11.—Hooked hair on fruit of *Circæa lutetiana*.

The surface of *Malva rotundifolia*, common mallow, is quite harsh to the touch on account of numerous rather stout one-celled hairs, one to six of which project from a conical protuberance. These stout hairs spread in every direction. Among the hairs

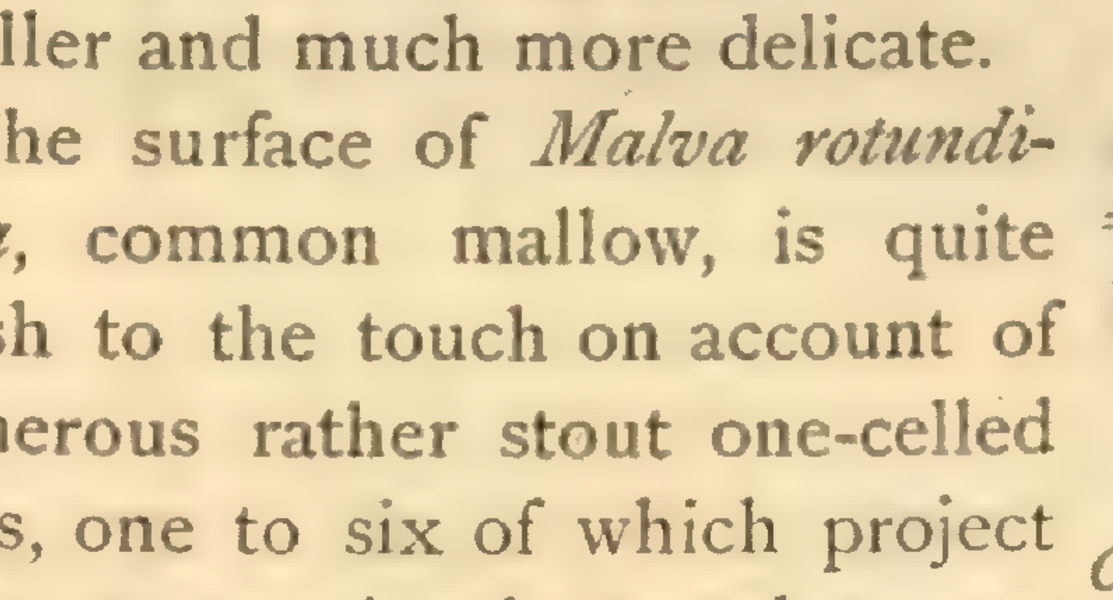

FIG. 12.
Hairs on *Malva rotundifolia*.

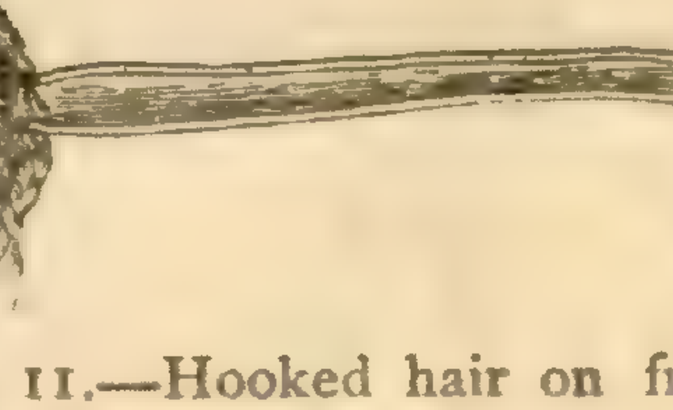

FIG. 13.
Sessile gland on same plant.

are a few sessile glands capped with two quarters of spheres.

The edges of the petioles of *Steironema* (*Lysimachia*) *ciliata*, a kind of loosestrife, are fringed with hairs, some of which are short and simple, while others are much larger and irregularly branched, like a stag's horn. Each hair whether simple or branching seems to consist of one cell, made of several pieces fitted together. The surface of *Leersia oryzoides*

FIG. 14.
Hairs on petioles of *Steironema ciliata*.

FIG. 15.—Hairs on *Leersia oryzoides*.

and *L. virginica*, rice-cut grass, is well supplied with short stout one-celled spines, all of which point downwards.

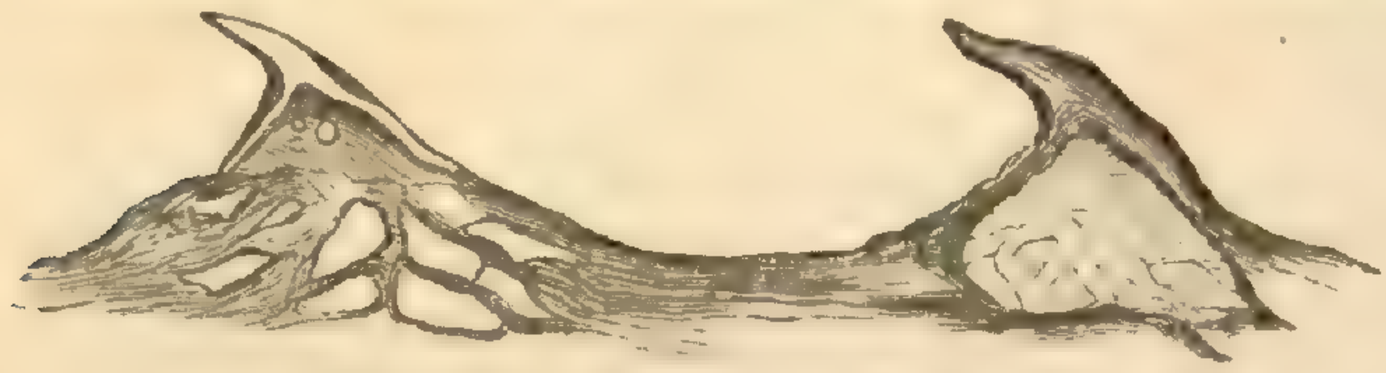

FIG. 16.—Hairs on *Galium*.

Several species of *Galium*, bed straw, are also supplied with hooks of a similar character. In these the base of each hook is quite broad and the point quite short.

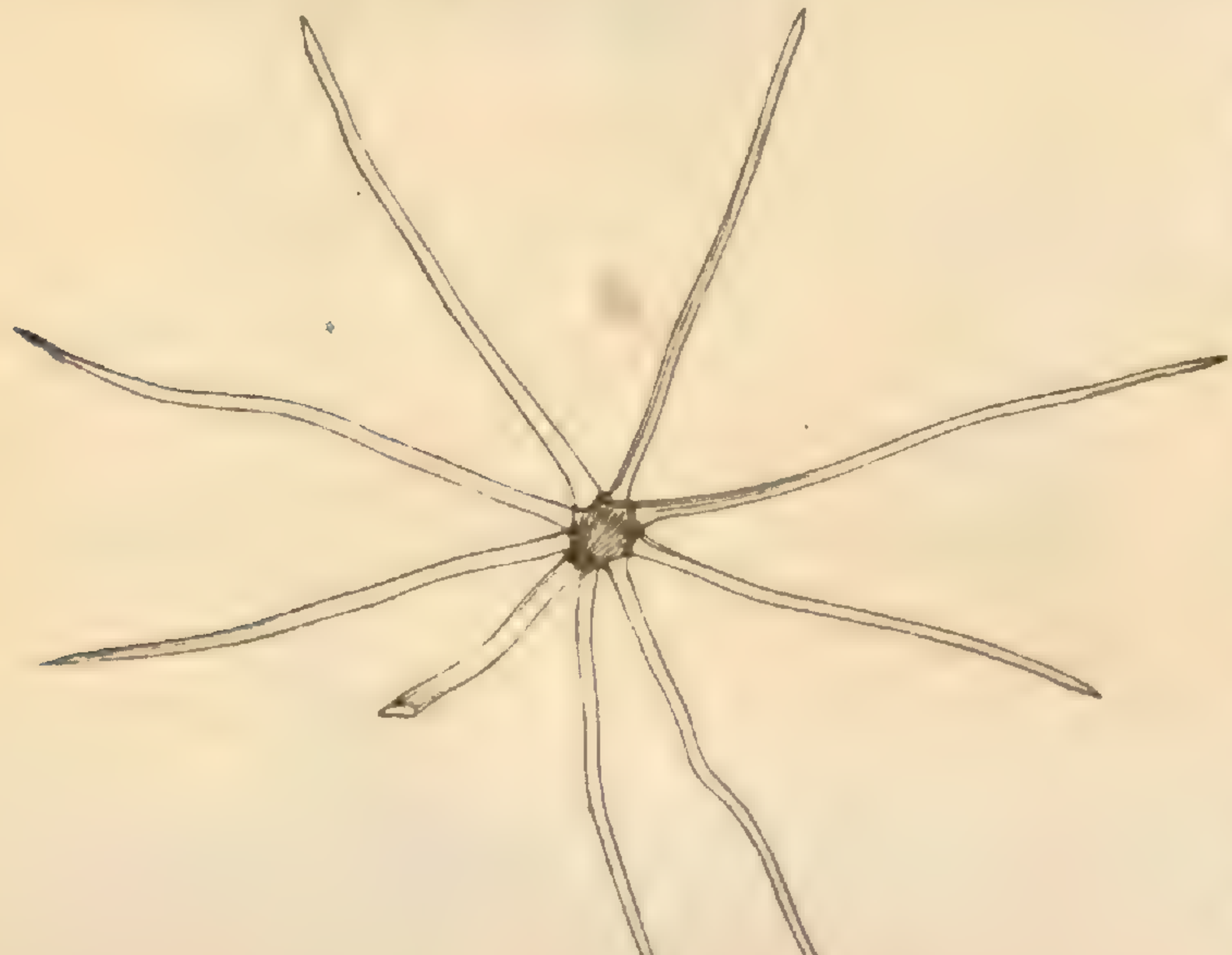

FIG. 17.—Hair on *Aralia papyrifera*.

The under surface of the leaves and the young stems of *Aralia papyrifera*, Chinese rice-paper plant, are thickly covered with a woolly substance which consists of immense numbers of one-celled stalks, each having at the tip six or more one-celled arms or rays which spread in every direction like the spokes of a wheel.

The common mullein is covered in every part with a still more abundant supply of branching hairs. The main axis of the hairs has radiating arms at different heights along its length. The glaucous nature of cabbage leaves and plums is due to numerous small cells on the surface. The mealy substance on pig weed, or lamb's quarter, consists in numerous capitate hairs.

Shepherdia canadensis is a rather rare shrub growing about the borders of lakes and seas. The young stems and buds, and portions of the leaves, are rendered red or rusty on account of the large number of scales, each of which is held to the plant by a short stem. Figs. 18 and 19 show two of

FIG. 18.—Branching hair on *Shepherdia canadensis.*

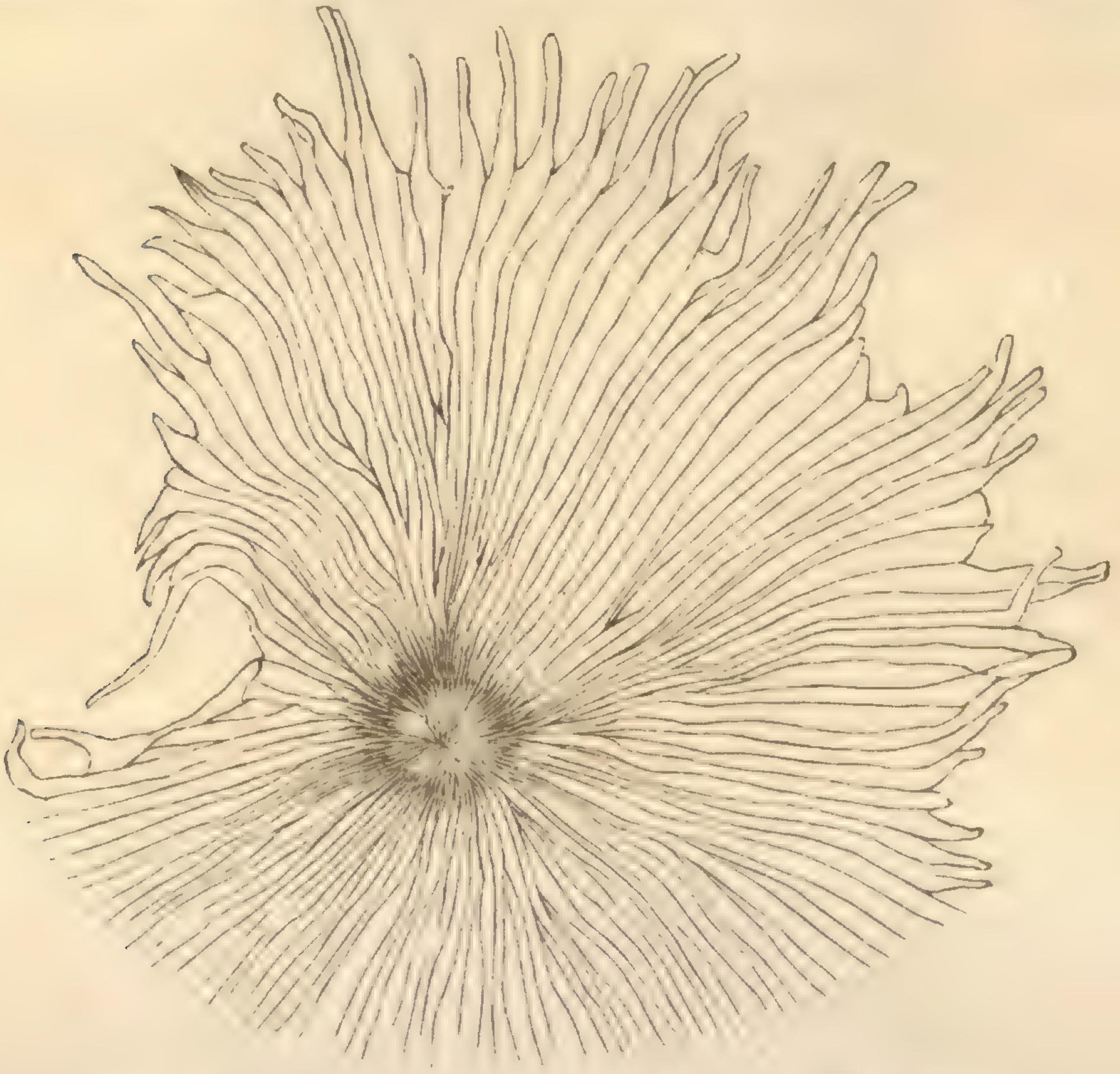

FIG. 19.—Shield-shaped scale on *Shepherdia canadensis.*

these objects. In Fig. 19 there are several rays attached side by

side throughout most of their length, while in Fig, 18 there are but few rays, which separate at once from each other. Between these two extreme specimens are found any number of intermediate forms. Much like the preceding are the star-shaped scales

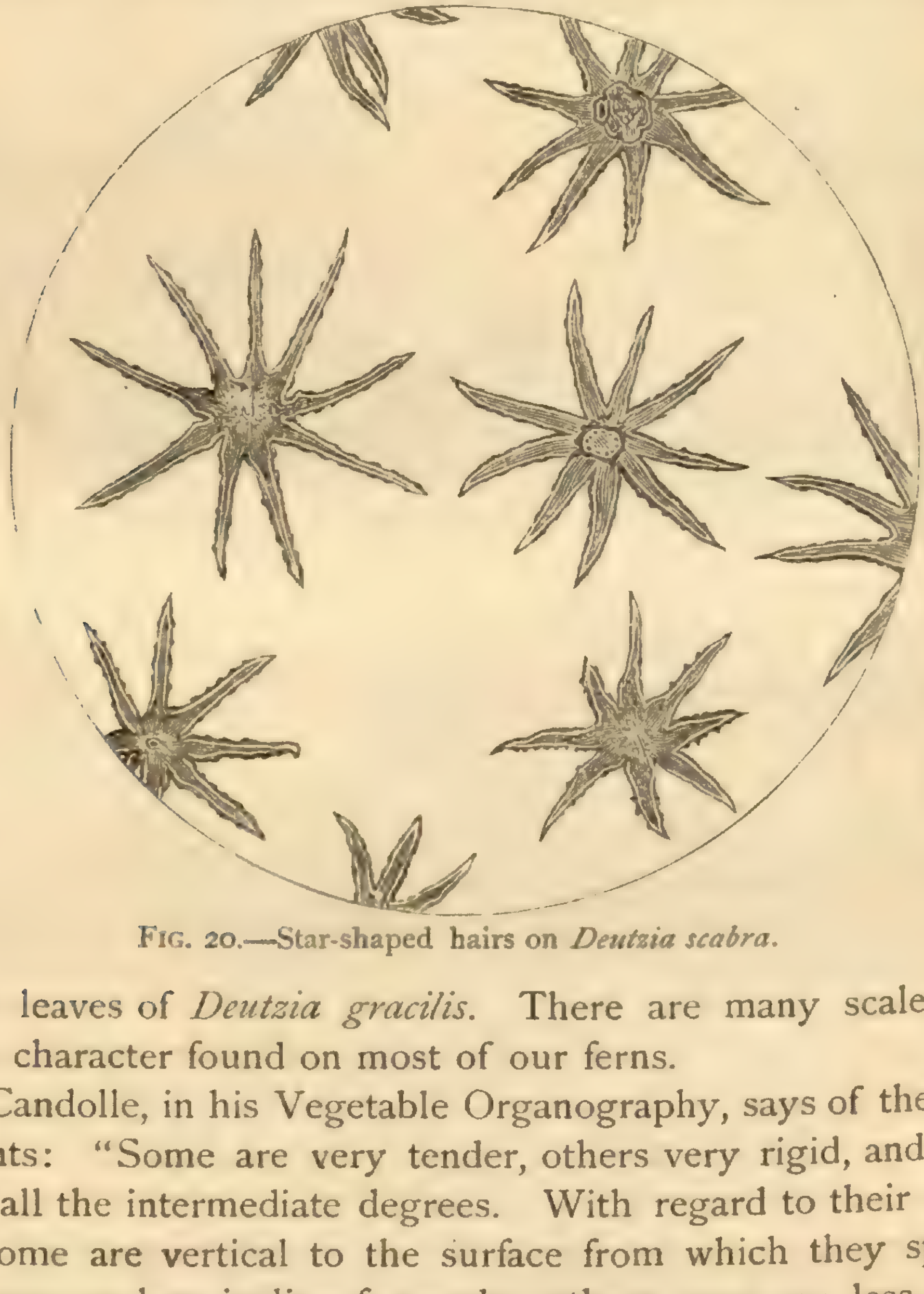

FIG. 20.—Star-shaped hairs on *Deutzia scabra*.

on the leaves of *Deutzia gracilis*. There are many scales of a similar character found on most of our ferns.

De Candolle, in his Vegetable Organography, says of the hairs of plants: "Some are very tender, others very rigid, and most are of all the intermediate degrees. With regard to their direction, some are vertical to the surface from which they spring; some more or less incline forwards; others more or less backwards; some are perfectly straight, others hooked at the point; there are several which are contracted, or which are interwoven with one another. As to their form, they are found as cylinders and very cylindrically-elongated cones. They are sometimes seen in the form of reverse cones, among those that are ramified they are found forked, with two, three or a greater number of branches; or starred at their apex, or divided at their base into branches which seem as so many distinct hairs reunited into bundles, having a common base."

Sachs says, "The first indication of the formation of hairs occurs in the papillose protuberances of the epidermis of many petals, to which their velvety appearance is due. To the simplest forms belong also the root-hairs which grow from the epidermis of true roots or underground stems (*Pteris aquilina* and *equisetum*), they are thin-walled bag-like protuberances of the epidermis cells which lengthen by growth at the apex."

The *Petunia* of our gardens is rendered sticky and unpleasant to the touch on account of one-celled glands raised

FIG. 21.
Glandular hairs of *Petunia*.

FIG. 22.

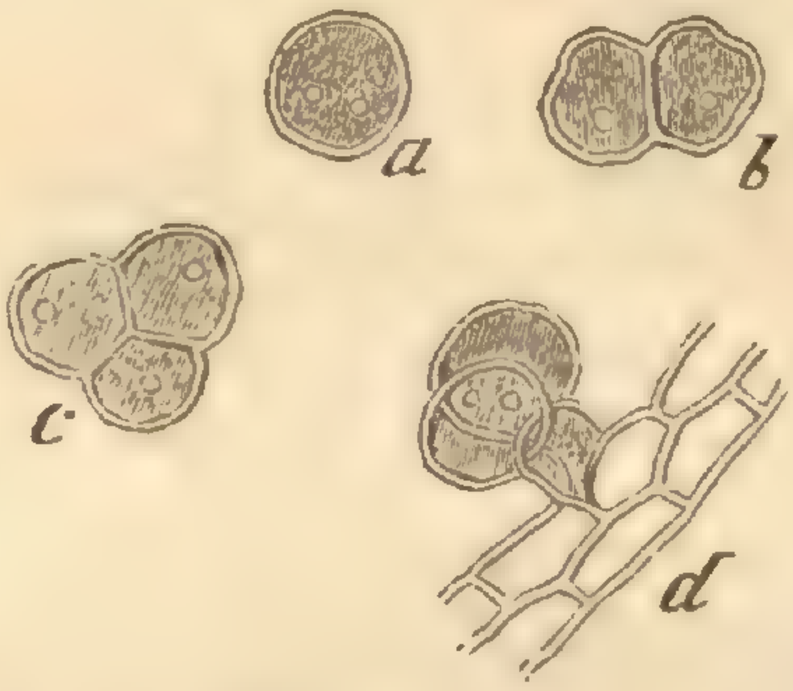

FIG. 23.
Glands on *Scrophularia nodosa*.

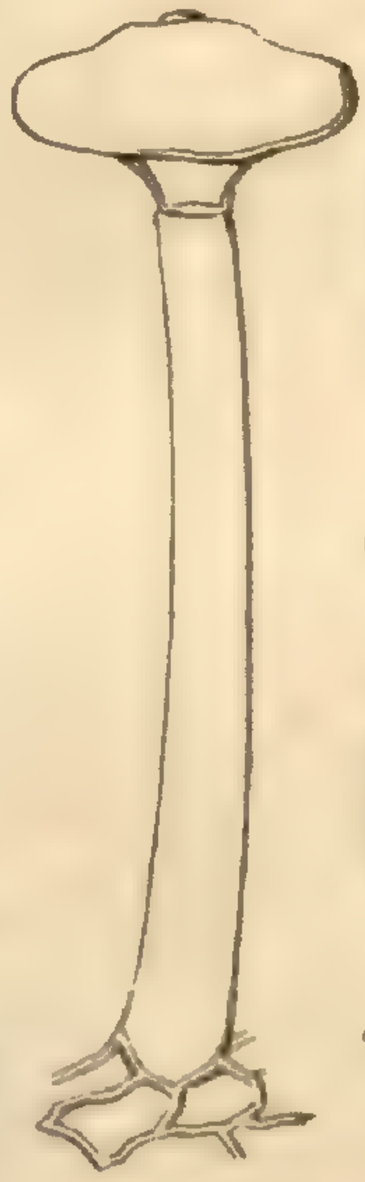

FIG. 24.
Glandular hair of *Verbena*.

FIG. 25.
Lower side of gland.

FIG. 26.
Top of gland.

on a stem of two to seven cells. *Scrophularia nodosa*, the figwort of our rich bottom lands, has numerous glands on its surface. These are composed of one, two, three or more cells raised on a short stalk. Some of the larger glands are more expanded into flattened spheres, and are much like those found on our garden verbenas next to be mentioned. The gland of the garden verbena consists of a large cluster of about thirty-five cells at the tip of a delicate stalk. The top of the gland is seen in Fig. 26, and appears to have about thirty rays and some central pieces of irregular shape. The lower surface of the gland, when it breaks off, shows two rings, one within the other. The inner is seen first, and on turning down the tube of the microscope the outer ring is seen. The gland is full of a purple substance. Figs. 27 and 28 exhibit the four-celled glands of the tomato plant. Each cell, as in many other cases, shows a nucleus, and some of them

one or more nucleoli. Besides the short hair and the gland of

FIG. 29.

FIG. 27.

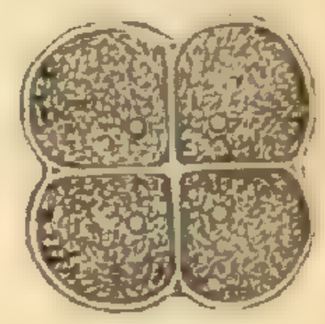

FIG. 28.

FIG. 27.—Side view of glands on Tomato. FIG. 28.—Top view. FIG. 29.—Hair and protuberance on Tomato.

the watermelon plant, shown in Figs. 30 and 31, there are large numbers of other very long-jointed hairs. Figs. 32 and 33 show us two hairs of *Phlox drummondii.* Here the glands appear to be composed of four or more cells. Some of the glands of this plant consist of a single cell. Fig. 34, *a*, *b* represent some of the smallest hairs on *Martynia proboscidia.*

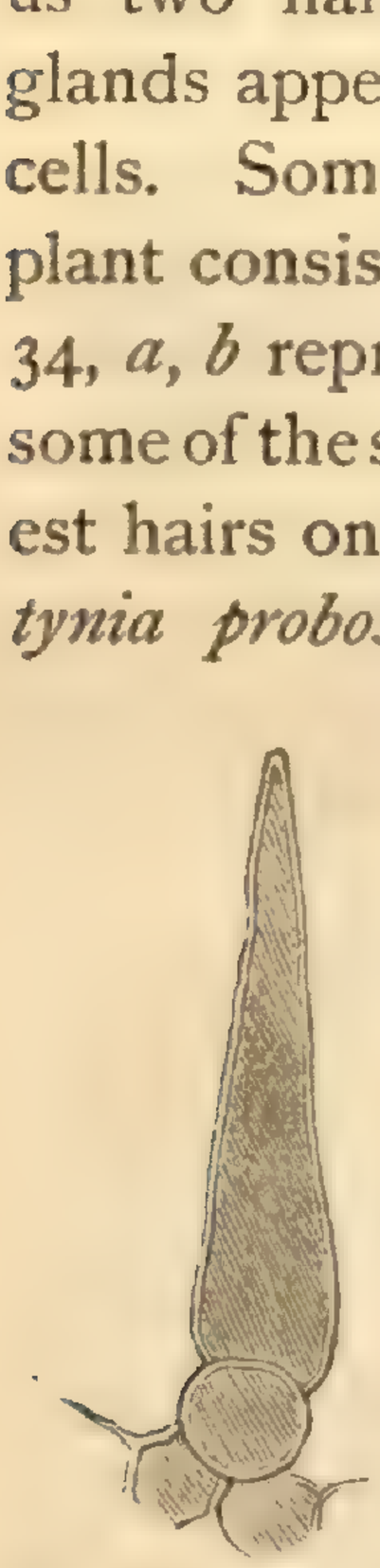

FIG. 30.
Short hair of plant of watermelon.

FIG. 31.
Glandular hair of watermelon.

FIG. 32.
Hair of *Phlox Drummondii.*

FIG. 33.
Hair of *Phlox Drummondii.*

Besides a few of these small hairs, the whole surface of the plant, including the sepals and petals, is thickly covered with glandular hairs as shown in Figs. 35, 36, 37. These glands, as do most glands of other plants to a greater or less extent, secrete a sticky substance which is usually increased in quantity by irritation.

From the end of the gland, when touched may be drawn out a gossamer thread of some length. The pulling out of the thread exhausts the gland in whole or in part, and causes it to collapse or change its shape. Fig. 36 shows a gland from which such a thread has been drawn.

FIG. 34.
Hairs of Petunia.

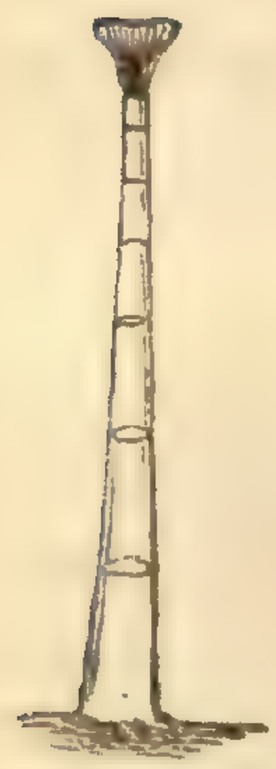

FIG. 35.

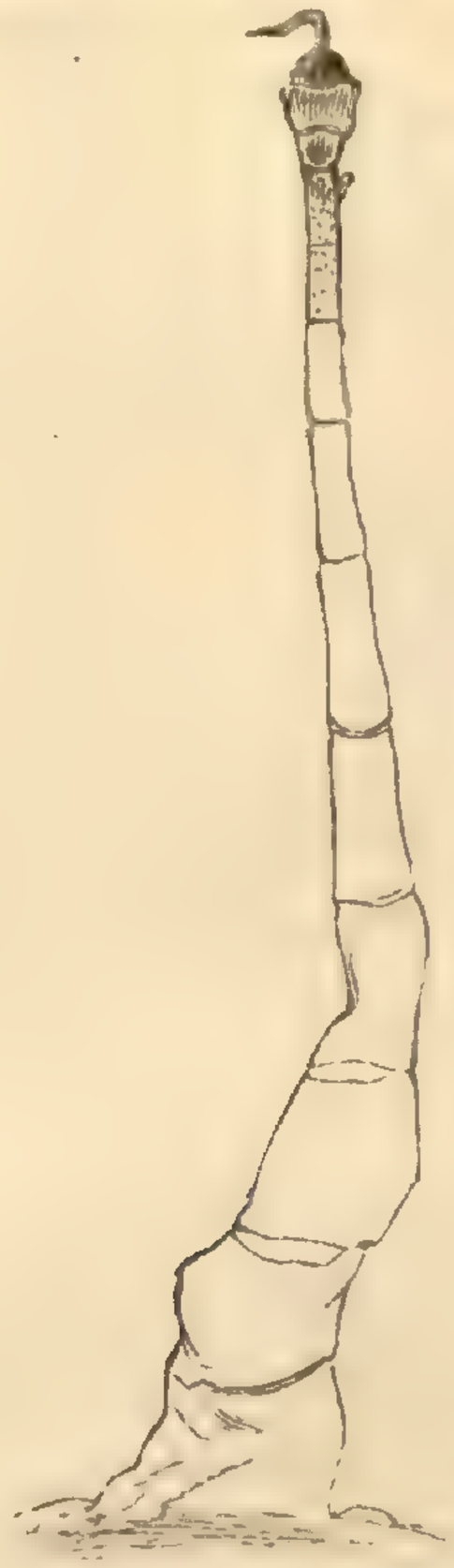

FIG. 36.

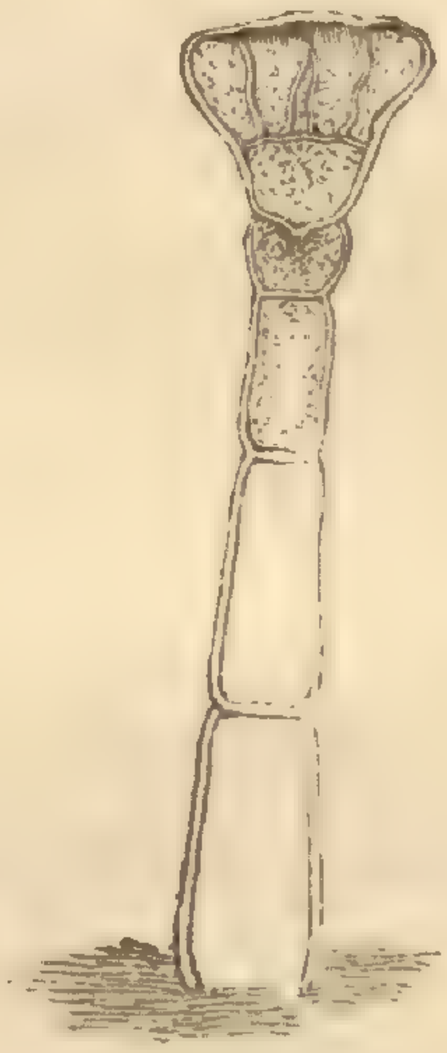

FIG. 37.

FIGS. 35, 36, 37.—Glands of *Martynia*.

The fruit of *Tecoma radicans*, trumpet creeper, has on its surface numerous sessile cup-

FIG. 38.
Tip of gland of *Martynia*.

FIG. 39.
Tip of gland of *Martynia*.

shaped glands of which Fig. 40 shows a vertical section. In damp weather, or when not exposed to very dry air, these cups

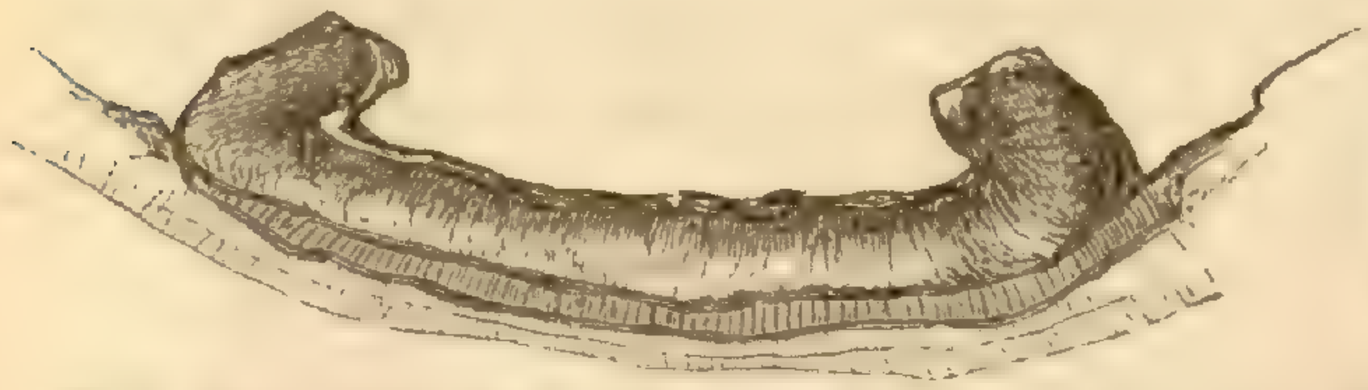

FIG. 40.—Gland of *Tecoma radicans*.

FIG. 41.—Spot on fruit of same.

FIG. 42.—Stoma on fruit of same.

are heaped full with a drop of glistening liquid in each. Besides these, on the surface are numerous spots, like Fig. 41, in which numerous cells are clustered into a circular form. From these we may find all gradations down to a two-celled stomate, as in Fig. 42.

On each margin of the petiole of *Viburnum opulus* and *Passiflora* are some cup-like glands which exude a sticky substance. Similar glands are found on the petioles of the cherry and some peaches.

For our present purpose enough of these hairs and glands have been described and illustrated. A large majority of plants possesses something of this nature in a greater or less degree. When fresh, and especially when not exposed to direct sunlight or air which is too dry, these glands are covered with a spherical glistening drop which is often several times the diameter of the gland.

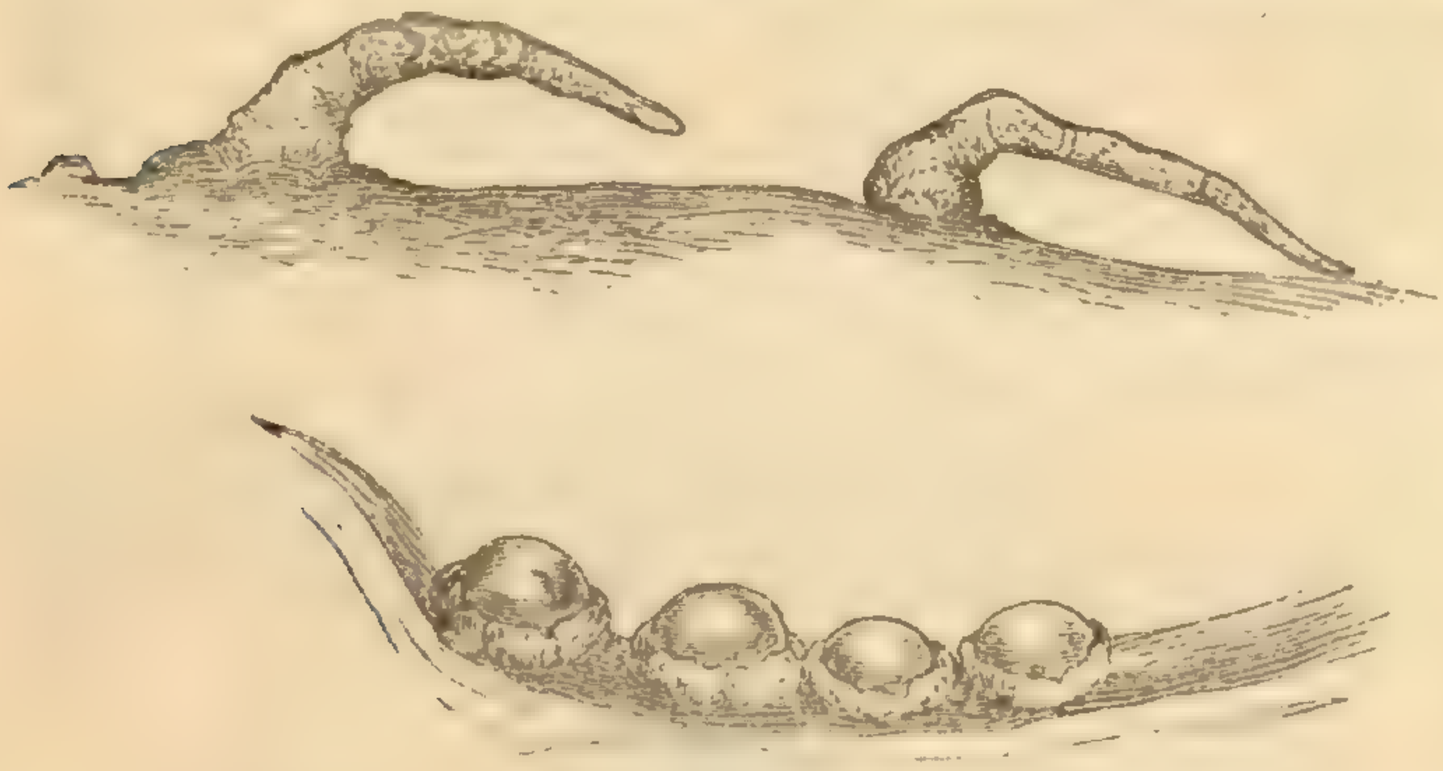

FIG. 43.—Glands on petiole of Snowball.

The uses of these hairs and glands we probably now understand to some extent, but in other cases we can only guess their office. The slender-pointed hairs may serve to some extent to ward off insects. These and the scale-like hairs may prevent the delicate surface from being scorched by the sun. This is not very probable, because most of the hairs on leaves are on the under side away from the direct rays of the sun. In the case of the common mullein, the thick branching hairs probably make the plant offensive to cattle and other animals. In a similar way other plants are protected from animals.

When packed within the bud scales during winter, the young leaves and flowers of many of our trees and shrubs are well protected by these soft hairs which envelope the tender parts like a mass of cotton or wool. After expansion of the buds these hairs generally drop off.

When the hairs or spines are stout and point backward, as in *Galium* and *Leersia*, they serve well to hold up the weak plant as it rises among stouter objects.

Fruit with hooked hairs is likely to be scattered by holding fast to animals. The bloom on a cabbage leaf or plum, and the thick hairs on plants prevent them from becoming wet on the surface. The shield and star-shaped scales on *Shepherdia* and *Deutzia*, and others, may serve the same purposes as hairs. These delicate objects must protect the plant from injury on account of sudden changes of the weather. The advantage of the sting of the nettle to the plant is obviously a means of self-protection.

The function of glandular hairs in some cases is a great mystery. In the case of *Martynia* the writer found it caught immense numbers of small insects, and in some way seems to suck out their substance. Small insects are found to a greater or less extent caught and held fast by the glandular hairs on all or most of the plants which produce glands. In his Insectivorous Plants Mr. Darwin, by experimenting, concludes that the glands of *Droseras* devour animal substances. The same conclusion is reached in case of numerous other plants, as some *Saxifragas*, *Primulas*, *Pelargoniums*, *Pinguiculas*.

The glands of the trumpet creeper are active, even till the fruit is of full size and quite near maturity. They are much visited by flies, wasps, and especially by ants to such an extent that the plant is often considered a nuisance when placed near the house. The glands on the leaves of cherry trees and *Viburnum* are also much frequented by insects. The base of the leaves of the sunflower, locust, *Pteris aquilina* (a fern) and numerous other plants are freely visited by insects. Of what benefit it can be to *Tecoma*, *Pteris*, *Heliantlus* and the cherry to be thus visited by ants is beyond my certain knowledge.

The glands of tomatoes, tobacco, petunia and many other plants secrete a substance which is offensive to most insects and other animals which might otherwise devour the plants.

Mr. Darwin has also shown that some of these plants do certainly absorb and appropriate gaseous and liquid bodies. Many ingenious experiments were made on plants of several different orders, showing that "they detect with almost unerring certainty the presence of nitrogen." Plants by their glands were fed with green-peas, raw meat, a decoction of grass leaves. These substances "are acted on in exactly the same manner as by gastric juice."

Why may not these glands also draw nourishment from the particles of dust which fall on them from the air, or from the particles of soil which in many cases accumulates to such an extent as to completely cover some portions of the plant? As root hairs are active in absorbing materials from the soil including something from solid substances, why should not these active glands absorb materials from the dust and fragments of soil? The free presence of the air and light may also assist in this supposed action. This covering of the plant by the particles of soil held by

the hairs and glands may also save the plant from destruction by animals.

Of one thing the writer is certain, that these delicate objects are interesting to study. Situated as they are in immense numbers and in such great variety on the surface of so many plants, they are easily obtained and easily prepared for examination. They are excellent objects for a beginner in the use of the compound microscope; and for protracted and careful experiments, they are worthy the skill of the most accomplished scientist. In them we may spend weeks to advantage in observing the development of cells, the nucleus and nucleoli, and the gyration of the sap. In form and color they are exquisitely beautiful, while in variety they are inexhaustible.

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ON THE TRANSFORMATIONS AND HABITS OF THE BLISTER-BEETLES.

BY CHAS. V. RILEY, A.M., PH.D.

[*Continued from the April Number.*]

History of Epicauta.—It is generally stated by writers on the Hive-bee that the Oil-beetle (*Meloë*) is one of its parasites. The possibility that our more common blister-beetles were similarly parasitic on bees, taken in connection with the frequent complaints from apiarians of the wholesale death of bees from causes little understood, led me, some years since, to pay attention to the biological characteristics of the blister-beetles, in the hope of ascertaining whether or not they really bear any connection with bee mortality. From these investigations I am satisfied that *Meloë* is only parasitic on the perfect Hive-bee as it is on so many other winged insects that frequent flowers; and that it cannot well, in the nature of the case, breed in the cells of any social bee whose young are fed by nurses in open cells.

I have had no difficulty in getting the eggs or the first larva of several of our vesicants, and described some of them at the Hartford (1874) meeting of the Am. Ass. Adv. Sc.; but these young larvæ refused to climb on to plants furnished to them, or to fasten to bees or other hairy insects. Nor would they nourish upon honey, bee-bread, or bee larvæ on which they were placed. They showed a proclivity for burrowing in the ground, and acted quite differently from those of *Meloë* or *Sitaris*, which not