Adaptation of Plants for the Distribution of Seeds.

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Outline

I. Sling Fruits.

1. By tension of a layer of cells in the fruit.
2. " dessication and contraction of a special layer,
3. " spiral torsion.
4. " separation of hard and soft layer of fruit.

II. Catapult Fruits.

1. Recoil of long, elastic stem.
2. Receptacle contains palea scales and teeth.
3. " basket shaped, closed in wet weather, open in dry.
4. Calyx bell shaped, hangs laterally, contains nutlets.
5. Short stalk, lignified cortical cells.

III. Dispersal by Means of Wind.

1. Those that roll on the ground.
   a. Fruits blown along the ground.
   b. Whole plants blown along the ground.
2. Those that stay in the air for some time.
   a. Membranous border to seed.
   b. Winged appendages " "
   c. Bracts and floral leaves transformed into envelopes.
   d. Parachute shaped mechanisms.
   e. Seed imbedded in masses of wool or hairs.
   f. " with hairy tails.

IV. Dispersal by the Aid of Animals.

1. Those whose fruits are eaten by animals.

a. Mammals — seeds mostly destroyed.

b. Birds.

1st class. — seeds mostly destroyed.

2d " — hard coated seeds not " ; soft-coated seeds destroyed.

3d class 75 per cent to 88 per cent uninjured.

2. Fruits that adhere to animals.

a. Due to mud, water, etc.

b. " " a sticky secretion.

c. Clawed or barbed processes.

I. Whole fruit claw shaped.

II. Fruit stalk " " .

III. Axis of the plant has barbs.

IV. Needle shaped processes.

d. Downy or parachute fruits.

V. Dispersal by Means of Water.

1. Seeds washed out by rains.

2. Fruits or seeds transported by rivers and oceans.

Adaptations of Plants for the Distribution of Seeds.

The forms plants take and the methods they adopt to distribute their seed so as to be of most benefit to the plant, and to insure their continuance, are innumerable. The modes of distribution, though in many cases they merge into each other, can be classified for convenience into five main groups, viz:

1. By Tension and Turgor – Sling Fruits.
2. Catapult Fruits.
3. Distributed by Wind.
4. " " Animals.
5. " " Water.

We will now take these up in regular order, and will give, as far as practicable, illustrations, showing the principal characteristic types of distribution of each of the sub-heads of the groups. There are four main types under the first head.

I. When the fruits of the plants of the first class become ripe, the tissue around the seeds becomes very tense. This tension soon bursts the tissue in

places; this is followed by the contraction of the tissues and expulsion of the seeds which rest upon them. The same effect is sometimes produced by the turgidity of the cells, or swelling up of the membranes due to the water contained. In the Squirting Cucumber, Ecballium Elaterium (Fig. 1, i) the fruit resembles a small cucumber covered with spines, and borne on a hooked stalk which projects into the fruit like a stopper. When the seeds are ripe, the surrounding tissue is transformed into a mucilaginous mass, the tissue about the stopper decomposes, and as there is a layer of cells in the fruit under great tension the fruit and stalk separate, and the mucilaginous mass containing the seeds, is forced out through the opening where the stalk was once inserted.

Another case is seen in the Wood Sorrel, Oxalis Acetosella (Fig. 2,) One of the deeper layers of the seed coat is composed of tense cells and is in a highly strained condition, while the outer layers

are not. When the fruits ripens, the cell membrane in the layer of tense tissue becomes swollen, and causes a rupture of the outer layers. The edges of the slit thus formed roll back, and a violent jerk is given to the seeds, which escape through the rupture with considerable force.

In another class of cases, the expulsion of the seeds depends upon the dessication and consequent contraction of a special layer of the fruit wall. As an example of this class we have those violets which have aerial stems, as Viola elatior (Fig. 3.) They have thin capsular fruits, each of which resolves itself into three valves, when it bursts open. These valves are boat-shaped, and the marginal parts which form the sides are thin, while the keels are very thick. Each boat-shaped cavity contains two rows of seeds. The valves are of a very complex structure, and the unequal dessication of these layers causes the lateral walls to curve up. As they approach each other, considerable pressure is exerted on the smooth seeds,

which are shot out with some violence. They are ejected in regular succession, the foremost seed of the carpel going first.

In the third class, as some Leguminosæ, and such as Mimoseæ, Cæsalpineæ, etc., the seeds are expelled by means of spiral torsion of the valves of the fruit, at the time that the legume or capsule opens. The wall of the fruit of these plants consists of two layers of cells; a soft succulent layer of parenchymatous cells, and a layer of hard, thickened, elongated cells, which cross the valve obliquely. Each of these hard cells winds ~~spirally~~ into a spiral as it dries, and induces a corresponding torsion in the entire layer. The torsion is very sudden and violent, as the soft layer offers no resistance, and the seeds are hurled to some distance. If the fruit is long, the spiral includes two or three coils, as in Cercis Canadensis (Fig. 4.) If short, it usually coils but once.

In the last class of this group, the hard and soft layers completely separate. When the seeds are ripe, the soft layer

~~dries~~

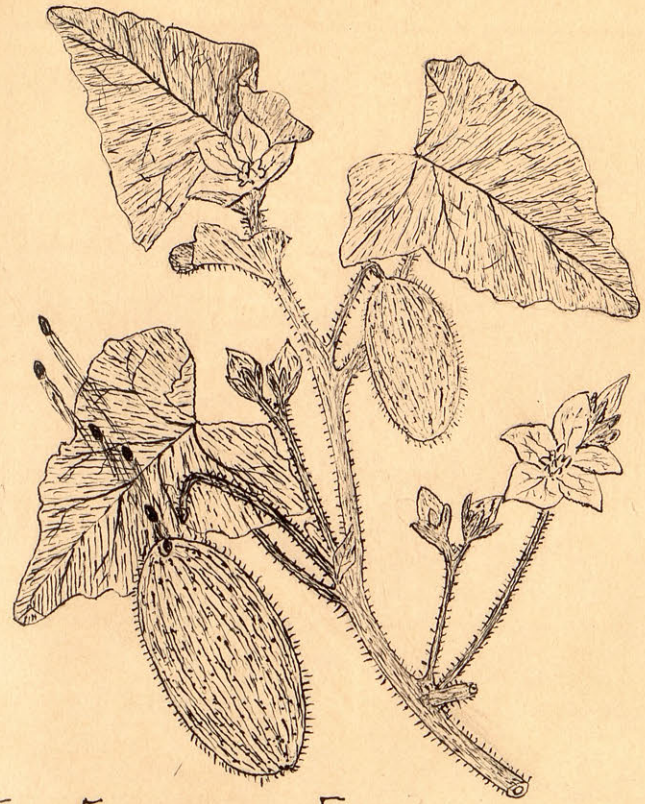


Fig. 1. Ecrallium Elationum.

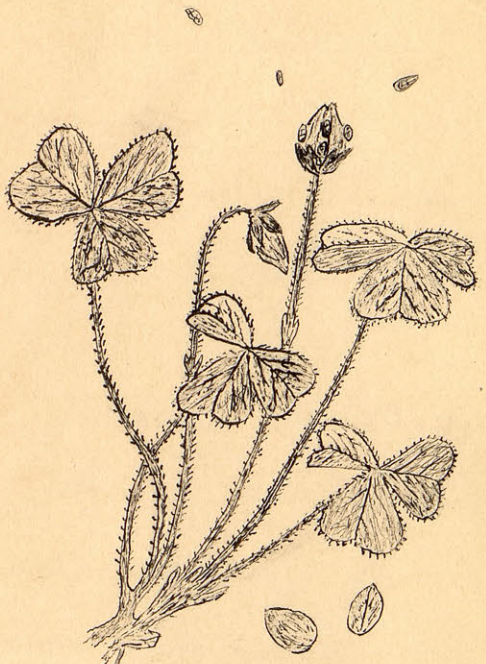


Fig 2. Oxalis Acetosella.

Fig 3.
Viola elatior

Fig. 4.
Orobus vernus.

Fig. 5.
Erodium.

Sling Fruits.

dries, and by its contraction, the inner hard layer, in the form of a case containing the seeds, is forced out of the rupture caused by the contraction. As soon as it is set free, its walls part, and eject the seeds violently.

Comparatively few plants distribute their seeds in this way, and these are usually found in localities sheltered from the wind. The angle of projection is about 45 degrees, the angle at which the seeds will go the farthest with a certain force of expulsion. This method alone does not scatter the seeds to any great distance, but it is often aided by the washing of rains.

II. A class of fruits allied to the sling fruits are called <u>catapult fruits</u>. They expel the seeds by the action of elastic stems and fruit stalks. They are strongly ~~resilient~~ and are strained by a force acting from without. There are five principal forms. The first three belong to the order Compositae.

The first form is that in which the

fruit is borne on long, elastic stems, which are set in motion by animals or other foreign objects touching them and then releasing them. The seeds are thrown out by the recoil which follows.

The second form is much like the first, except that the receptacle is clothed with palea, and the fruits have no pappus. A shock sends the seeds up among the scales, where, as they cannot return on account of the upturned tuft, they work their way to the top, where they lie till the wind gives the plant a shock and they are thrown out.

In the third form, the involucral scales form a basket of the receptacle, in which the fruits lie. In damp weather the scales close together, and when dry they raise up and the hairs of the pappus raise up also and bring the fruits to the mouth of the basket. As the peduncle is set in motion, the fruits are tossed out.

In the fourth form the calyx is bell shaped, and packs laterally. The fruits are in the shape of spherical, ovoid

nutlets. (Figs. 606.) If pressure is brought to bear on the stiff point of the calyx, the pedicel is subjected to a strain, which, when the pressure is removed, springs back to its former position, and the nutlets are shot out with great force. The path of projection is determined by calyx teeth, or convergent hairs in the calyx tube.

In the last form of this class, the fruits are borne on short stalks, in spikes or long clusters. The cortical cells of the stalks are lignified. There is a layer of separation between the stalk and the fruit. The style is a decurrent beak, terminating in two hooks. As an animal or other object touches the fruit, it separates at the layer and springs away. The pressure applied to the fruit is transmitted to the stalk, which remains in a sort of tension till the pressure ceases, and the fruit is cast away with great force. A good example of this is Polygonum Virginicum (Fig. 5.) There are also a few plants that adapt-

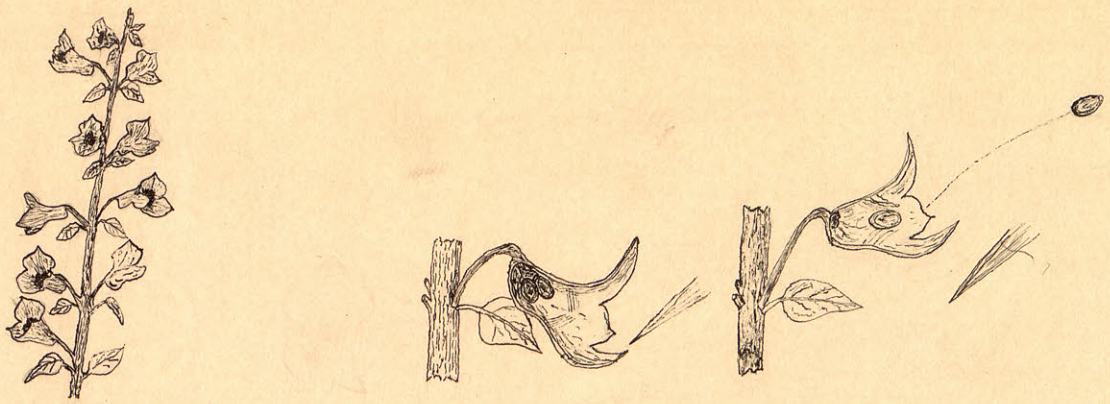


Fig. 6. Teucrium Euganeum.

Fig. 7. Salvia verticellata. 1/2. Fig. 8. Polygonum Virginicum. 3, 4.

Catapult Fruits.

their fruits for distribution by means of appliances for creeping or hopping on the ground. These are very few, and do not get their seeds dispersed to any great distance.

III The third general method of distribution, by means of the wind, is usually found in regions where a long period of drouth follows a short summer season. The adaptation of plants for distribution by this means are very varied and extensive. They can be divided into eight main divisions.

1. The first class is that in which the fruits are blown along the ground by the wind. These fruits are very light; due to a layer of very light material in their structure. In some species of clover there are only a few perfectly formed flowers in the cluster at the end of the flower-stalk, while many abortive flowers are crowded together in the middle of the inflorescence. As the legumes form from the fertile flowers, the calyx teeth of the abortive flowers assume the shape of long, hairy bristles which bend over and form an enclosure about the

legumes forming a ball. These balls become detached from the stalk, and are rolled away by the wind.

2. Entire plants are thus rolled for long distances in this manner, sometimes scattering their seeds as they go, but often retaining them till lodged against some obstacle, where they are washed out by rain.

There are innumerable cases in which the seeds or fruits remain in the air for some time. In these the seeds are always more or less flattened, and their center of gravity is so placed that they put their broad side in the direction of descent.

3. A compressed seed is usually surrounded by an attenuated margin, membranous border, or fringe of fine processes as in Bignonia, (Fig. 9,) and Dioscorea (Fig. 10.) In some cases, the entire pericarp is modified in this manner, as in the elm, (Ulmus Americana, Fig. 11.)

4. Other classes have winged appendages attached to the seeds. These either arise from the seed coat or the carpels. Some fruits

have a single wing attached to the one fruit, as in Centrolobium robustum (Fig. 13) or one on each of double fruits, as in Acer Negundo. (Fig. 14.) The mesocarps of Hyporhax erectus (Fig. 15,) have wings projecting from the back. The fruits of Polygonum Sieboldi, (Fig. 16,) have three wings, while those of Triopteris bifurci (Fig. 17,) have four. In the case of Dryobalanops (Fig. 18,) the floral leaves are transformed into wings. In the Gyrocarpus Asiaticus (Fig. 19,) segments of the calyx are similarly adapted. The bracts are also sometimes used for this purpose, as in Tilia Americana.

5. Some seeds are distributed by the transformation of bracts or floral leaves into thin delicate envelopes, which adapt them to dispersion by winds.

6. One of the commonest methods is by a mechanism of hairs or membranous borders in the shape of a parachute. In Cnicus albida and Eupatorium altissimus (Figs. 20 and 21,) but one of the poles of the seed is furnished with a tuft, whereas, in Adenium Honghel (Fig. 22,) both poles are so provided.

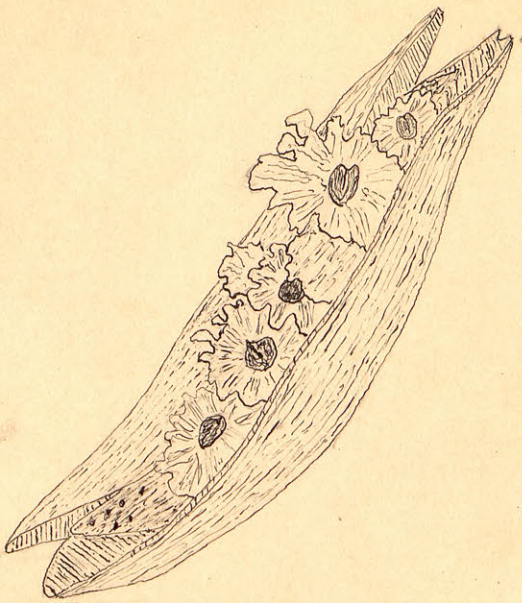


Fig. 9. Bignonia.

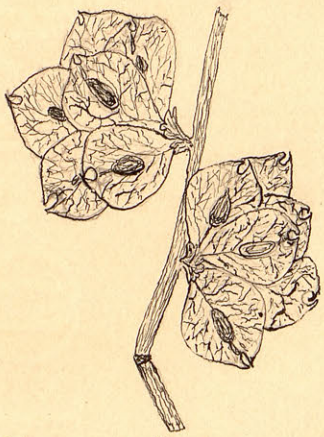


Fig. 11. Ulmus Americana.

Fig. 10. Dioscorea

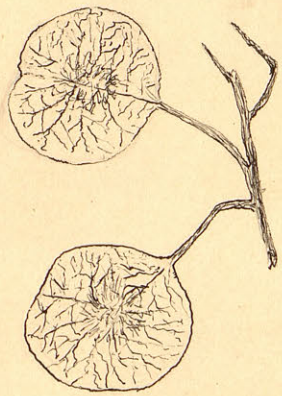


Fig. 12. Ptelea trifoliata.

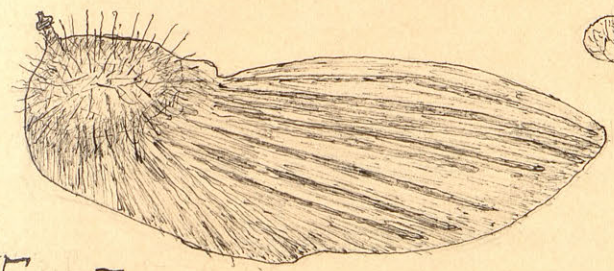


Fig. 13. Centrolobium robustum

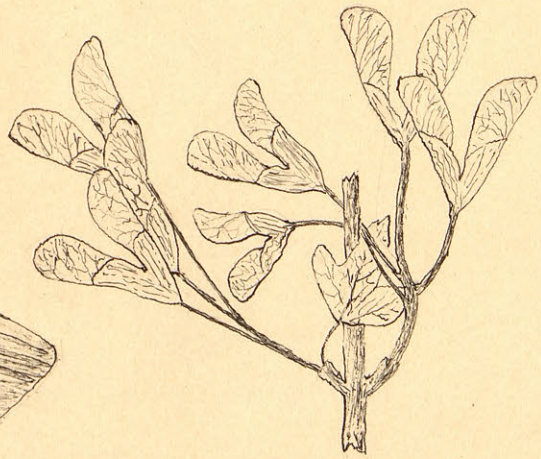


Fig. 14. Acer Negundo.

FRUITS DISTRIBUTED BY WIND.

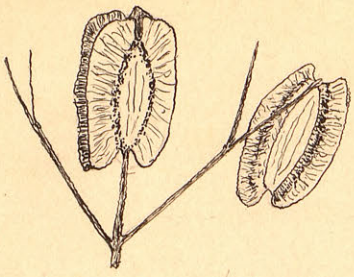


Fig. 15. Opoponax Cretica.

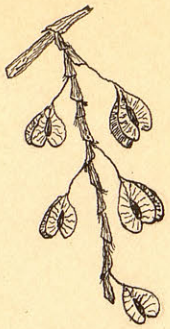
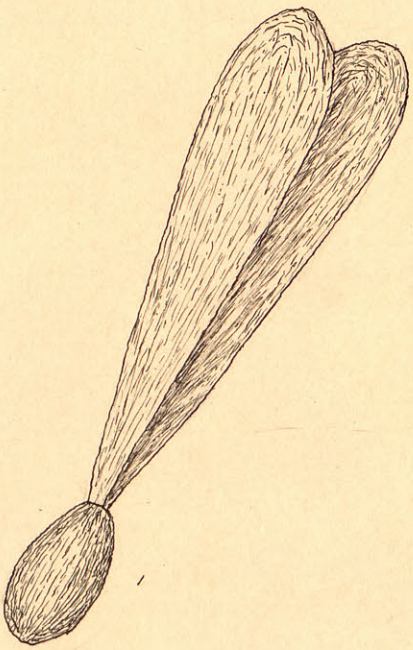


Fig. 16. Polygonum Sieboldi.



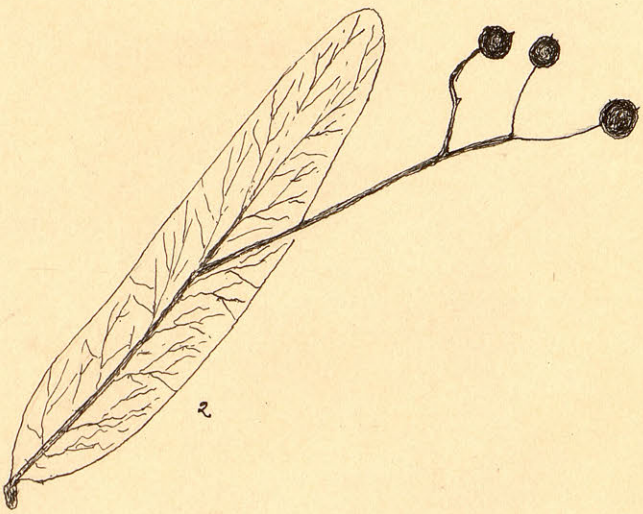


Fig. 19.—1 Gyrocarpus Asiaticus. 2. Tilia Americana.

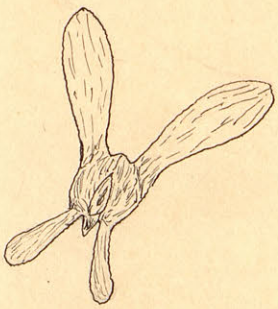


Fig. 17. Triopteris bifurca.

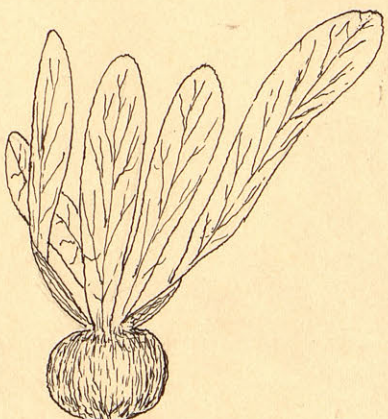


Fig. 18. Dryobalanops.

FRUITS DISTRIBUTED BY WIND.

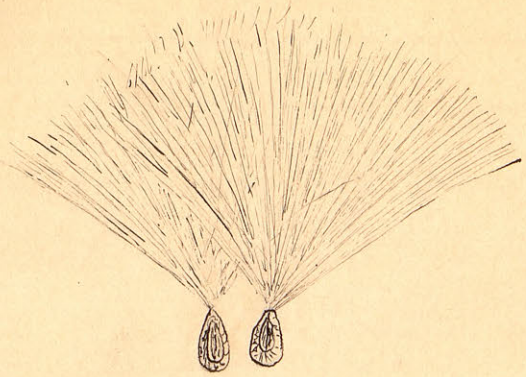


Fig 20. Enslenia albida

Fig. 21. Eupatorium altissima.

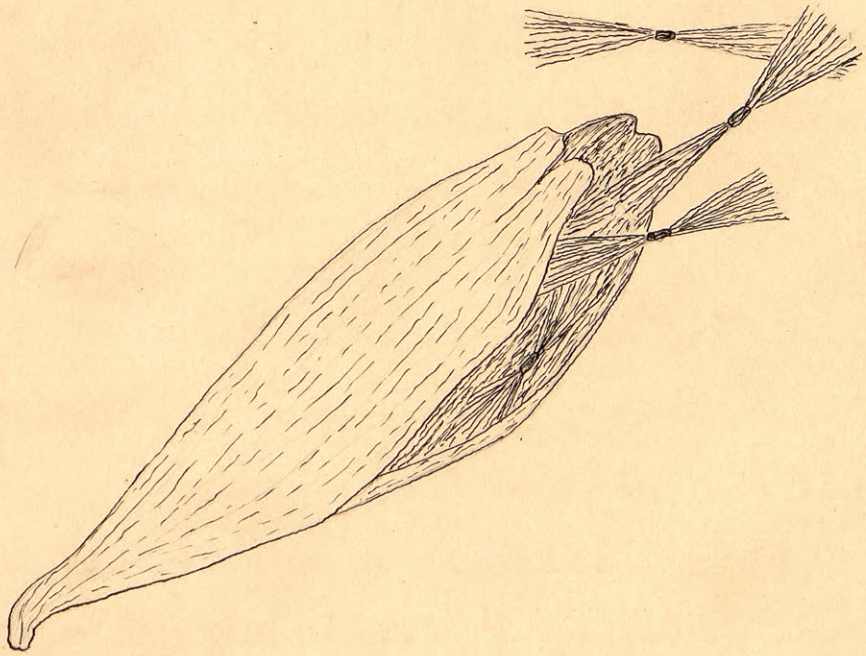


Fig. 22. Adenium Honghel.

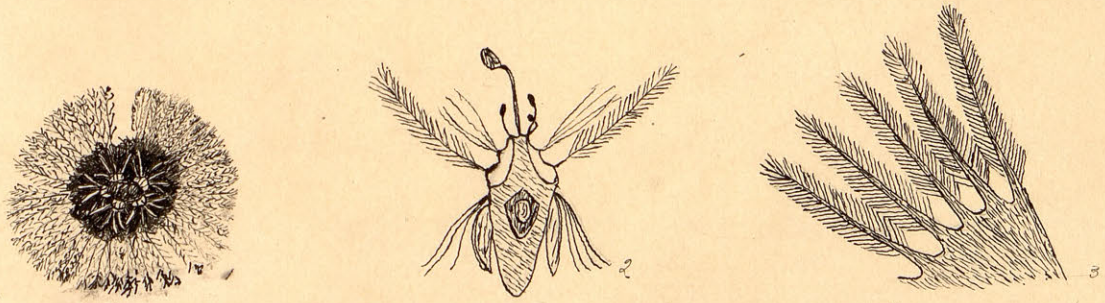


Fig. 23. Verticordia oculata. 1. fruit; 2. long. section; 3. "feathers".

Fruits Distributed by Wind.

In *Verticordia oculata* (Fig. 23.) the parachute is formed by five petals in the form of fans, each composed of ten feather-like lobes.

7. Another class of fruits adapted to wind distribution is those which are imbedded in masses of wool or envelopes of silky hairs. The hairs may arise from the surface of the seed coat, as in *Bombax* (Fig. 24.) and *Gossypium Barbadense* (Fig. 25.) or from the base of the seed as in the willows; eg. *Salix Myrsinites* (Fig. 26.)

8. In another case, the fruits or seeds are kept suspended by means of hairy tails. The tails may be at both ends, as in *Eschynanthus speciosus* (Fig. 27.) in which the small seeds are furnished with two long hairs, or the style lengthens after the flower has faded and becomes converted into a spirally curved tail, which is attached to one side of the achene, and acts as a parachute; ex. *Clematis Flammula* (Fig. 28.)

The distance to which these fruits are carried depends upon the perfection of their mechanism, the condition of the air,

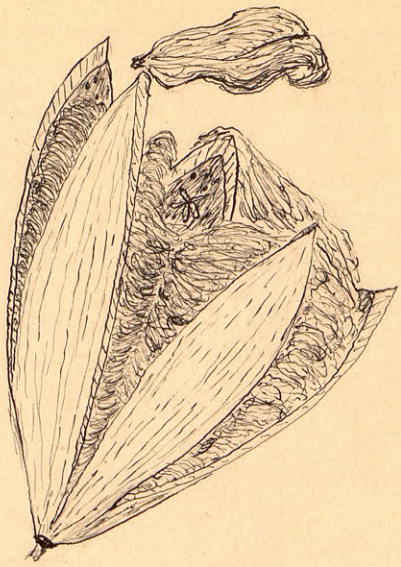


Fig. 24. Bombax.

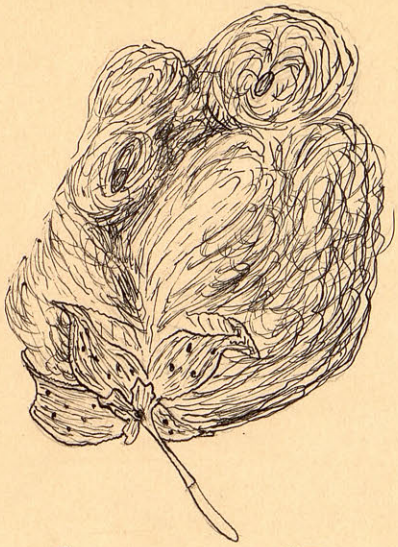


Fig. 25. Gossypium Barbadense.

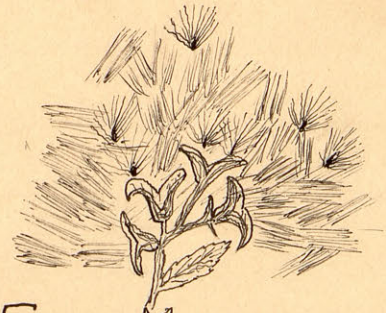


Fig. 26. Salix Myrsinites.

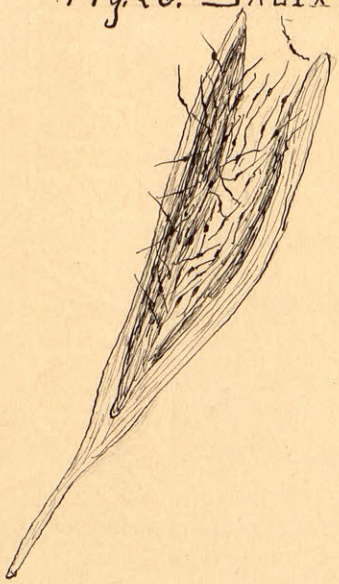


Fig 27. Aeschynanthus speciosus.

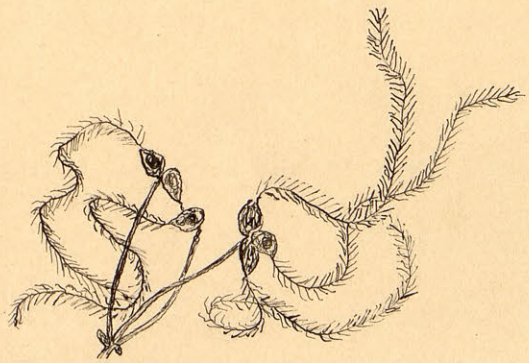


Fig. 28. Clematis Flammula.

Fruits Distributed by Wind.

and the strength of the wind. In the winged and tufted fruits, the appendages usually fall off when they blow against some obstacle. Nearly all of the winged fruits are borne some distance above ground, to enable the seeds to float as far as possible from the parent plant. Tufted fruits, on the other hand, are usually borne near the ground, as the wind can readily raise them and carry them long distances.

IV The fourth method of distribution is through the agency of animals. The ways in which plants and fruits are adapted to the distribution of seeds in this manner are very numerous.

In many cases the fruits containing seed are eaten by animals, and the seeds excreted uninjured, though in the case of mammals the seeds are mostly destroyed. Birds may be divided into three classes as to their efficiency in distributing seed in this manner. In birds of the first class, that grind their food by means of gravel or sand, in a muscular gizzard, the seed is ordinarily destroyed. The second

groups, composed of ravens and jackdaws, destroy the soft coated seeds, while the hard coated seeds are uninjured. In the third group, composed of blackbirds, robins, thrushes, etc, from 75 per cent to 88 per cent of the seeds taken in with the food passes out uninjured. The fleshy fruits are mainly disseminated in nature in this way. Their bright color and sweet taste when ripe attract animals, while their green color and sourness repel them when unripe. Plants with green foliage usually have red colored fruit, as it contrasts with green, while plants whose foliage, at the time of ripening of the fruit, is light, or brightly colored, have blue or black fruits. Those that cast their foliage before the fruit is ripe have white fruits. Some fruits also attract animals by their sweet scent, as the raspberry, strawberry, etc.

Insects also play an important part in the distribution of such seeds as may serve as food for them. This is especially true of the ant, which often moves grains many times its own weight.

These intentional modes of dispersion are comparatively rare, being of use only to those plants which have fleshy fruits. The unintentional mode is much more common, and consists of the fruits hanging by hooked appendages, sticky secretions, etc. to animals, and being dislodged as incumbrances.

The adhesion of fruits and seeds to the feathers of birds and the skin or fur of other animals, is due either to the agency of mud, water or wet earth, or to a special sticky substance which is secreted by some plants. In many aquatic or marsh plants, the fruits or seeds have no secretion or organs of attachment, but are scattered by clinging by means of drops of water to water-fowls, etc, which carry them to other ponds or marshes. Many small fruits and seeds are attached to birds which go to the water's edge to drink, by means of mud or boggy earth, especially in the migrating season, when the birds neglect to clean themselves as usual. The plants which distribute seeds in this way

are usually those which grow on or near the edge of the water. Rain-soaked earth in the field or by the wayside, helps to attach many seeds to roving animals and thus to secure their dispersion.

The secretion of sticky substances by plants secures the adhesion of seeds to the fur of animals or feathers of birds, and in this way a wide distribution is obtained. As examples of these we have the Meadow Saffron and Wormwood bush. Water fowls often break open the fruits of the water-lily to secure the seeds, many of which often stay on their bills if they are suddenly startled, and are wiped off when they reach another pond. Other plants are provided with special glandular hairs or stalked glands by which they attach their seeds to animals. These appendages spring from the epidermis, and have on their surface viscid or slimy substances. Many different parts may be thus provided. In the Pisonia aculeata (Fig. 29,) it is the pericarp; in Salvia glutinosa (Fig. 30,) it is the calyx; and in Linnaea borealis (Fig. 31,) it is a pair of bracts.

It is estimated that about ten percent of all flowering plants distribute their seeds by means of clawed or barbed processes. These appendages stick to the hairs, bristles, or feathers of animals that come in contact with them, and, as they are a source of great discomfort, they are gotten rid of as soon as possible. But as many of them cling tenaciously, they are often carried to considerable distances before they are discarded. The appendages are either hooked at the end, or beset with barbs. The latter are borne on rigid bristles or needles, and are either collected in a group at the top, or arranged in longitudinal rows. They are nearly always borne on the pericarp, and vary greatly in size. In the case of the Devil's Claw, (Martynia proboscidea, Fig. 32,) the claws are about four inches long, and form curved arms facing each other, and placed at nearly right angles to the axis of the fruit. These claws are developed from the pistil, which grows together when green, but separates when ripe forming the tough elastic claws. They are very

common in the western part of Texas. Some of the most remarkable forms are the capsular fruits of Triumfetta Plumieri (Fig. 33) the sheathed achenes of Rumex mexicanus (Fig. 34,) the pods of the common beggar tick, (Desmodium canadense Fig. 35,) the mitten of Cynoglossum pictum (Fig. 36,) the involucral claws of Xanthium canadense — the common cocklebur — and many other contrivances of a more rare occurrence. Such cases are, the bending of sepals to form claws, transformation of calyx teeth into hooked prickles, the presence of prickles on the achenes of some Compositae, barbed perianth bristles, and the crowning of the expanded receptacle with hooked prickles.

Sometimes the whole fruit is claw-shaped and also possesses large prickles. Achenes of several Compositae are claw-shaped and are provided with a crown of sharp, curved, barbed at each extremity of the claw. In the Trapella sinensis, an aquatic plant, the fruit is supplied by three long appendages, wound up like watch springs, which readily attach themselves to aquatic birds, or even fishes. The fruit is

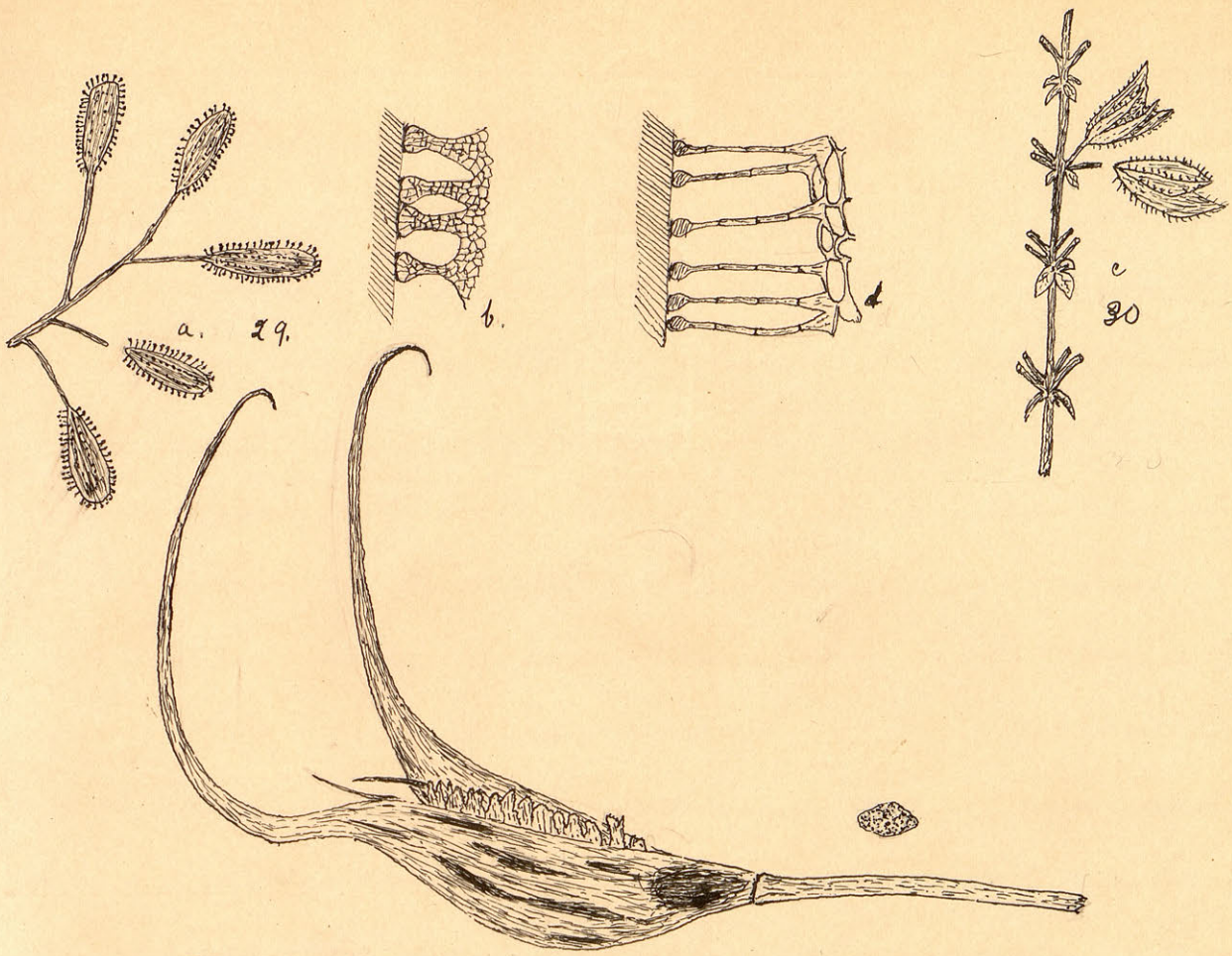


Fig. 32. Martynia proboscidea.

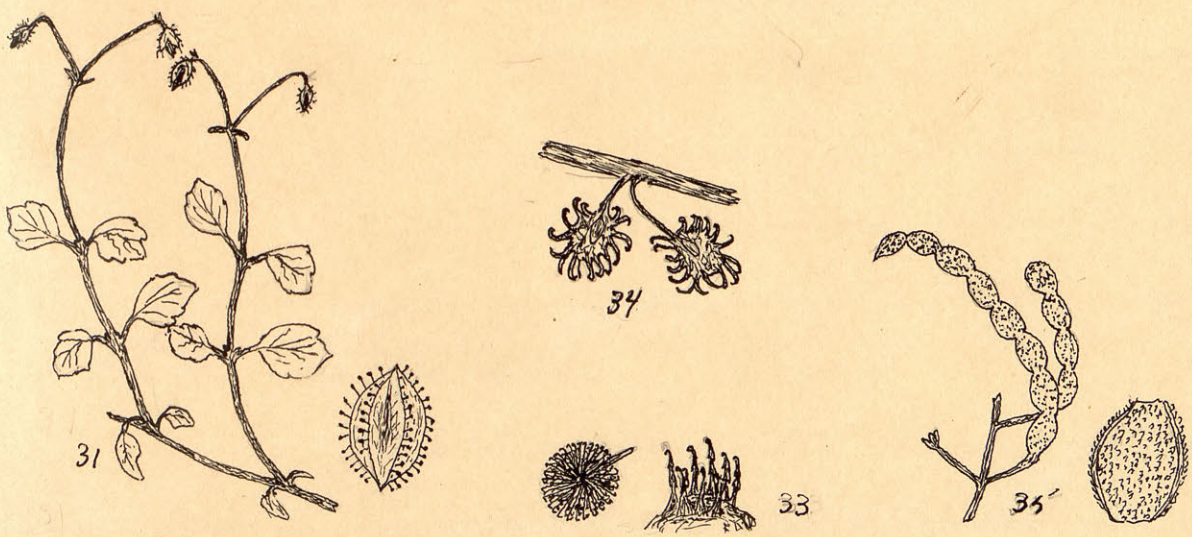


Fig 29. Pisonia aculeata ; 30. Salvia glutinosa.
" 31. Linnaeus borealis ; 33. Triumfetta Plumier.
" 34. Rumex nepalensis ; 35. Desmodium canadense.

FRUITS DISTRIBUTED BY ANIMALS.

protected against being eaten by two sharp, stiff, spines.

In other plants, the fruit-stalk is transformed into a claw-like structure. In Cyclamen Europaeum the fruit stalk undergoes spiral torsion and contraction. This draws the capsules underground in the fall, where they remain till matured the following summer. The capsule is pulled out of the ground by desiccation and swerance of its fruit-stalk, where it remains till some animal treads on it and carries it off.

Another class of prickles are those formed from branches or abortive flowers situated on special ramifications. Pleranthus echinatus (Fig. 37,) has several short branchlets in each inflorescence, and abortive flowers with hooked sepals.

In another class the hooks or claws are fixed firmly to the axis of the plant, and when they adhere to an animal, a large part or all of the plant is carried away; as in Galium verum (Fig. 38.)

Another mode, which is somewhat

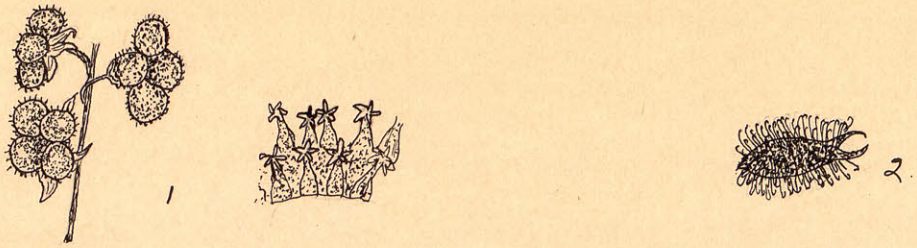


Fig. 36: 1. Cynoglossum pictum. 2. Xanthium canadense.

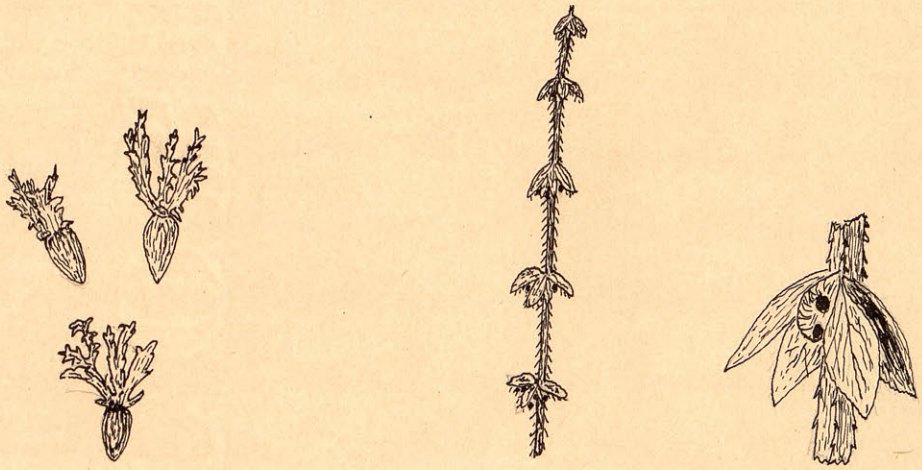


Fig. 37. Pteranthus echinatus. Fig. 38. Galium retrorsum.

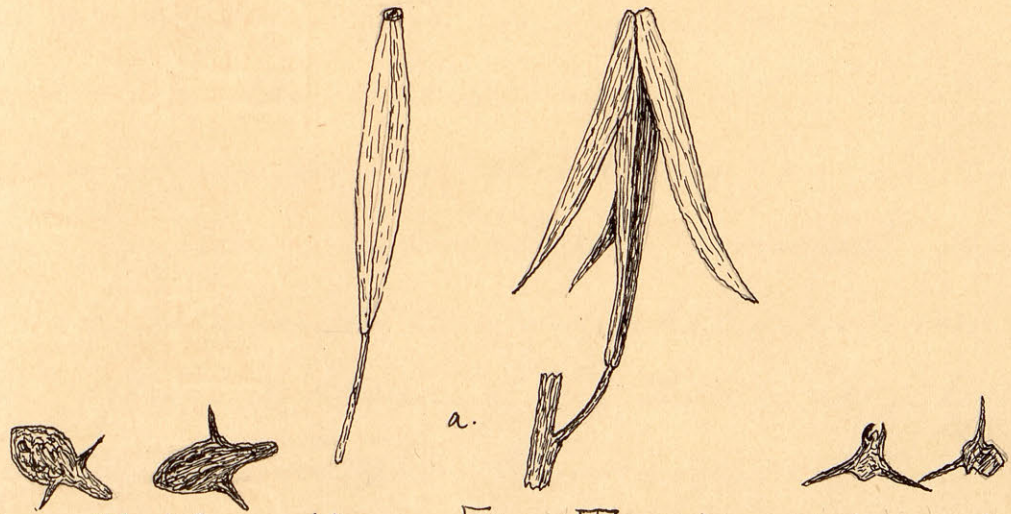


Fig. 39. Pedalium Murex. Fig. 40. Tribulus orientalis.
a, Triglochin palustre.

Fruits Distributed by Animals.

painful to the animal, is where the fruit has straight, smooth prickles projecting from it, which either bore into the foot of the unlucky animal, or sticks into his sides. There are two main groups of these plants. The first group are those that lie loose upon the ground, in which the tips of the fruiting calyx are transformed into two hard spines, which stand upright; example, Pedalium Murex (Fig. 39,) and Tribulus orientalis (Fig. 40.) The latter class are much dreaded by Hungarian shepherds, as they are very dangerous to stock. The second group bears the fruit on a stiff, erect axis, and point obliquely downwards when ripe. They are easily detached, and remain sticking in the skin or fur of the animal that touches them. Fruits with straight or slightly curved bristles are often dispersed in this way, by becoming entangled in the hair or wool of animals. Those fruits and seeds which are covered with hair or have hairy parachutes, sometimes also become entangled in the fur of animals and are distributed.

V The last and least important of the methods of distributing seeds, is by means of water. There are comparatively few plants which distribute their seeds in this way entirely, though rain is often effective in aiding some of the other methods. There are two principal ways in which distribution in this manner is secured; by the washing out of the seeds by rain, and by transportation of seeds or fruits in the water.

The best known representative of the first class are the "Roses of Jericho". One of these, Anastatica Hierochuntica (Fig. 41,) a Cruciferae which grows on the steppes of Egypt, Arabia, and Syria, has its branches folded inward and together in such a way as to form a trellis around the numerous, closed, pear shaped siliquas to prevent them from being touched. When moistened, these branches straighten out, the fruits open, and the seeds are washed out by the rain.

The second class is best represented by the cocoa-tree. It bears large, woody fruits, which are covered by a thick

fibrous husk, in a large cluster, and these are able to float long distances in the sea, and lodge on distant shores. The tree is a palm and is a native of oceanic islands. (Fig. 42.) As it is a tropical plant, its distribution will not be effective, except in tropical lands, but considering the usefulness of the tree, in which almost every part is put to use, its distribution to all the tropical lands is the source of a large number of profitable industries.

We have in as few words as possible, tried to give all the principal modes of dispersion, and by drawings, tried to illustrate some of the characteristic forms of each, and while we have not been minute in our descriptions, we hope that a general idea of the subject is set forth.

ANASTATICA HIEROCHUNTICA. 1 Dry, 2. Wetted.

Fig. 41.

Fig. 42. Cocoa. Tree.

FRUITS DISTRIBUTED BY WATER.