CHAPTER

11

Plant Movement (Growth Movements)

11.1 GENERAL ACCOUNT

The movements may be defined as the displacement of the entire living being or an organ or even the protoplasm from one place to another place.

Movements are of universal occurrence in plants, although, not so apparent as in animals. Mostly animals can move from one place to other place while the majority of plants remain fixed and they show certain movements *e.g.*, growth of an organ phototropic and geotropic movements etc. This difference between the movements of plant and animals is only of degree and is related to the fundamental difference in their mode of nutrition.

The movements in living beings (plants or animals) are brought about by change in the environments. The plants are sensitive changes in the factors of environment like light, heat, touch, pressure etc. The change in the environment induces a change in plants and called *stimulus,* and the reaction of plant to the stimulus is called the *response.* The irritability or sensitiveness (response of a plant to stimulus) is a fundamental property of living protoplasm.

11.2 AUTOMNOMIC AND PARATONIC MOVEMENTS

Movements of plants may be broadly classified into two groups which are :

(i) Movement of Locomotion

(ii) Movement of Curvature

Movements of Locomotion

The movements include the cilinary movement of unicellular or colonical algae, bacteria, rhythemic movements of *Oscillatoria* and amoeboid movements of slime moulds. These movements may be of following types :

1. Autonomic Movements of Locomotion

The movement which exhibit locomotion by cilinary action *e.g.*, *Volvox, Chlamydomonas* or gliding *e.g.*, diatoms or rhythemic movements *e.g.*, diatoms or rhythemic movements *e.g.*, *Oscillatoria* due to the internal stimulus *i.e.*, takes place spontaneously in the protoplasm, known as autonomic movements of locomotions.

2. Paratonic or Tactic or Induced Movement of Locomotion

These movements are governed by external stimuli like chemical, light, temperature etc. hence are called as induced movements. These may be of the following types :

(a) Chemotaxis : These movements are governed by some chemical stimuli *e.g.*, antherozoids in most of plants move towards archegonium due to some chemotactic attention of sugar jucice secreted from archegonia.

(b) Thermotaxis : These movements take place in response to heat. For example if a rectangular vessel filled with ice cold water containing *chlamydomonas* is warmed on one side the unicellular plant will begin to move towards and collect on warm side.

(c) Phototaxis : These movements take place in response light, *e.g.*, pand algae moves towards the shaded bank, because of its attraction towards the weak light and repulsion from the strong light rays.

Movements of Curvature

These movements are usually shown by higher which are fixed to the ground. These movements of curvature mostly performed by certain parts of plants as a result of unequal growth in one or the other directions, hence are also called *''growth movements''*. The curvature movements may be of the following two types :

(i) Autonomic or spontaneous movements of curvature.

These movements take place in plants according to their own accord.

(ii) Paratonic or Tactic or Induced movements of curvature.

These movements of plants are governed by some external stimuli.

(iii) Autonomic movements of curvature.

The movements of curvature which take place in plant according to their own accord, may be of the following two types :

(A) Growth movements

(B) Various movements

(A) Growth movements

These movements are due to unequal growth to different sides of the plant organ. This types of movements are quite common to weak stemmed plants. The autonomic growth movements may be of the following types :

(a) Nutation : Sometimes there may be greater growth on one side of the stem then the rest and the maximum growth may pass a little later on the opposite side and subsequently alternate between them. Thus the apex will alternately incline first to one sie then to the other, exhibiting a kind of nodding movement in the two directions. This type of movement is quite common in the seedlings of twiners.

(b) Circumnuation : In this type the growth is rapid on one side and slower on the other resulting into encircling of twiners and tendrils round the support.

(c) Epinasty : In this type of movement; the greater growth on the upper surface of bifacial structure like leaves take place *e.g.*, opening of circinate leaves in ferns.

(d) Hyponasty : In this type of movement the greater growth on the lower surface bifacial structures like leaves takes place *e.g.*, formation of circinate leaves in ferns.

Movement of Variation

(i) Autonomic curvature movements of variation

The movement of variation is the movement of mature organs due to variation in the turgidity of the cells making up those organs. This type of movements is best seen in the India telegraph plant-*Desmodium gyrans*. The plant has a ternate compound leaves, with a large terminal and two small lateral leaflets. Normally these two leaflets move up and down form morning till evening *i.e.*, so long as sunlight is available rarely they may continue to move till late hours at night depending on the energy that they have conserved from the sunlight during the day times.

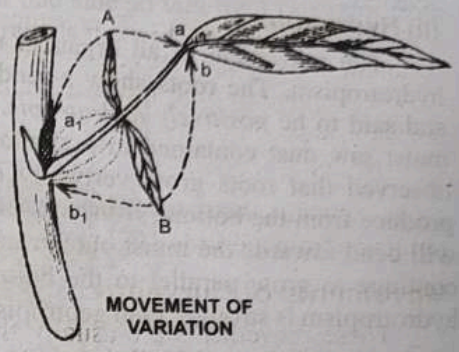


Fig. 1 : Indian telegraph plant (Desmodium gyrans) leaf showing movement of variation

(ii) Paratonic or Tactic or Induced Movement of Curvature

The movement of curvature which takes place in plant organs as a result of some external stimuli such as light, heat, chemicals etc. may be of the following type :

(A) Growth Movement

(B) Variation Movement

(A) Growth Movement

(Induced or Paratonic growth movement of curvature)

The movement can furthers be either.

(a) Tropic or Directional : Mostly in stem root etc.

(b) Nastic or Non-directional : Mostly in flowers etc.

(a) Induced Directional growth movement of curvature Or Tropic Movement of Tropism

These movements commonly occurs in rapially symmetrical organs like stem, root and always directive *i.e.*, the direction of movement isd determined by the indirection from which the stimulus is applied, and the organs move either towards the source of stimulus or away from. The tropic movements depending upon the nature of stimulus may be of many type. The chief external stimuli are contact, water, light, gravity and chemical substances, and the movements induced by them are as follows :

(i) Thigmotropism or Haptotropism

These growth movements of plants organs are in response to the stimulus of contact of friction. In this type of movement the part of the plant when comes in contact with any support or body *e.g.*, climbing of weak plants due to holding of support or by the tendrils or hooks in *Dioscorea. Glorosa, Nepenthes, Clematis Nasturitium,* etc. Thigmotropic responses are induced only when the tendrils are actively growing. Perception of the contact stimulus is in some cases, as in certain

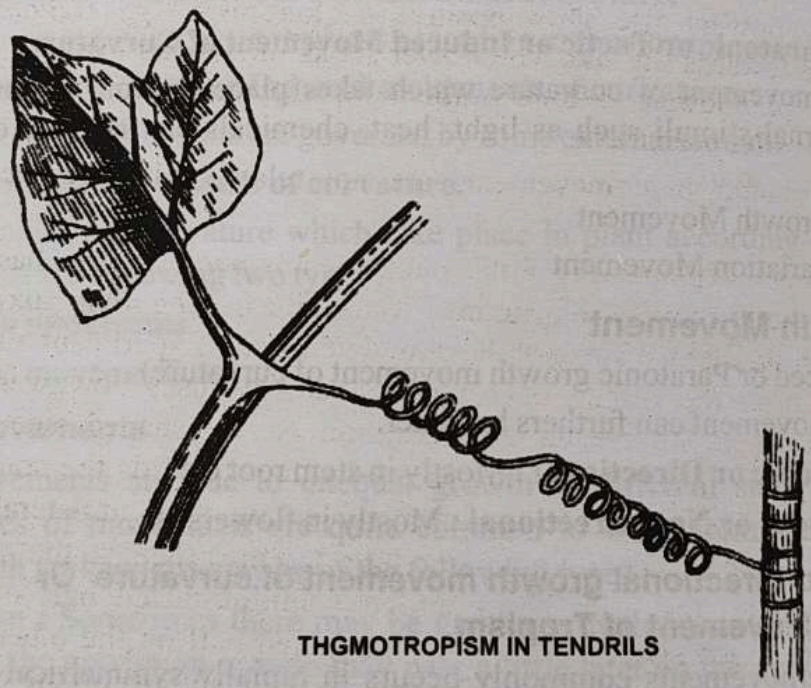
species of cucurbitaceae, associated with the presence of special ''tactile pits'' on the tendrils. Thigmotropic responses are also ment within the roots.

(ii) Hydrotropism

The movement of an organ in reponse to the moisture stimulus is known as hydrotropism. The roots show a tendency to grow towards the source of moisture and said to be *positively hydrotropic*. This may be proved by germinating seeds in moist saw dust contained in a shallow vessel with perforated bottom. It has been observed that roots grow vertically downward due to gravitational pull and they produce from the bottom. If the vessel is inclined at an angle to the vertical the roots will bend towards the moist out surface of the vessel as if seeking moisture and will continue to grow parallel to the bottom. By the experiment we may conclude that hydrotropism is stronger than geotropism.

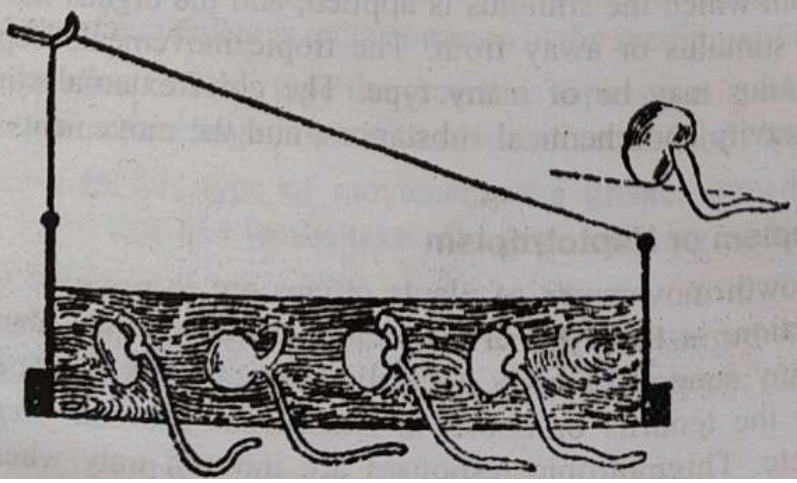
(iii) Phototropism or Heliotropism

The movement of plant organ are due to the stimulus of light rays. It is well known tha shoots (stem, leaves) are *positively phototropic i.e.,* they bend towards light while; roots are *negatively phototropic i.e.,* they move towards dark.



THGMOTROPISM IN TENDRILS

Fig. 2 : Thigmotrophic movement in tendrils of Mukia scabrella.



Phototropic responses on stems can be best seen by growing young seedlingsd in a phototropic chamber. This chamber consists of a box, covered and black painted on all sides and is provided with a window on one side so that light can enter from that side. This shows that stem always move towards the window from where light is coming.

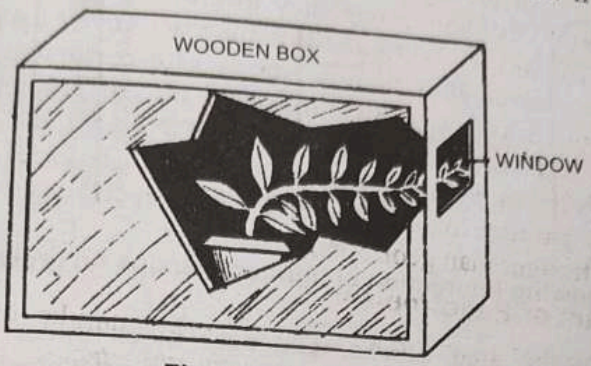


Fig. 4 : Phototropism

Many flowers also show positive phototropism *e.g., Heilanthus* (sunflower) which face towards the sun. The flower stalks of *Arachis hypogea* (ground nut) are positively phototropic before pollination, they perform negatively phototropic movements after pollination.

The phototrophic movements are not related with presence or absence of chlorophyll.

A proper explanation of the phenomenon *phototropism* has come only as a result of the discovery of auxins. It has been seen that auxins have unequal distribution on the two sides of the stimulated stem. Experiment also prove the auxin is produced in the region of perception and diffuses downward to the zone of elongation where its greater concentration on the shaded side cause accelerated growth on the side thus resulting in a curvatuer towards the source of light. Went F.W. excised the coleoptile tip after subjecting it to unilateral illumination and placed the tip on two agar blocks separated by mica sheet so that the illuminated half of tip rested on one agar block and the unilluminated half on the other blocks separated by mica sheet so that the illuminated half on the other block. The blocks were the fixed eccetrically on different coleoptile stumps on the dark. By this we see the production of negative growth curvature which proves that auxin must have

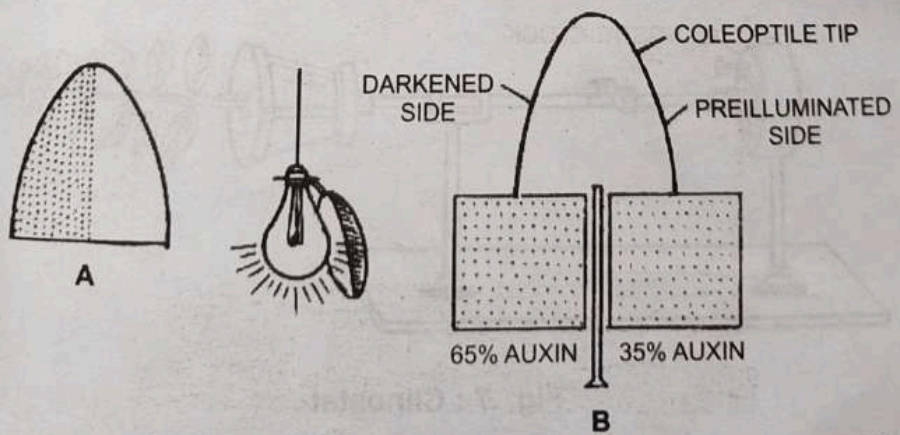


Fig. 5 : In as unilaterally illuminated coleoptile in the hormone accumulates more on the shaded side than on illuminated side.

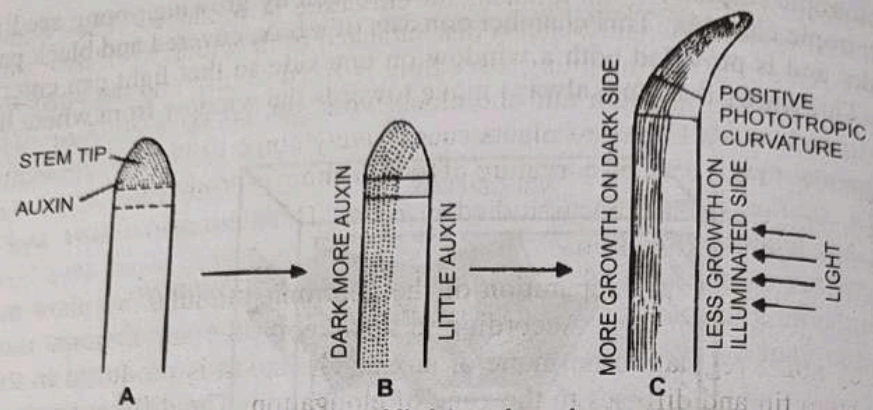


Fig. 6 : Showing interaction of light and auxins on growth of stem

diffused down into the agar blocks. The agar block under illuminated half of coleoptile tip produced a greater curvature than other agar block showing that there was more auxin on the shaded sine that the illuminated side. he experiment also prove that if tip of coleoptile kept in dark the auxin was uniformly distributed. Thus we may conclude that redistribution of auxin takes place under the influence of unilateral illumination.

(iv) Geotropism

The movement of any part of plant governed by the direction of the force of gravity is called *geotropism,* Normally the roots grow towards centre of gravity *i.e., positively geotropic* and shoots (stem) away from gravity *i.e., negatively geotropic.* The lateral roots and branches usually grow at right angles to the force of gravity and are said to be *diageotropic.*

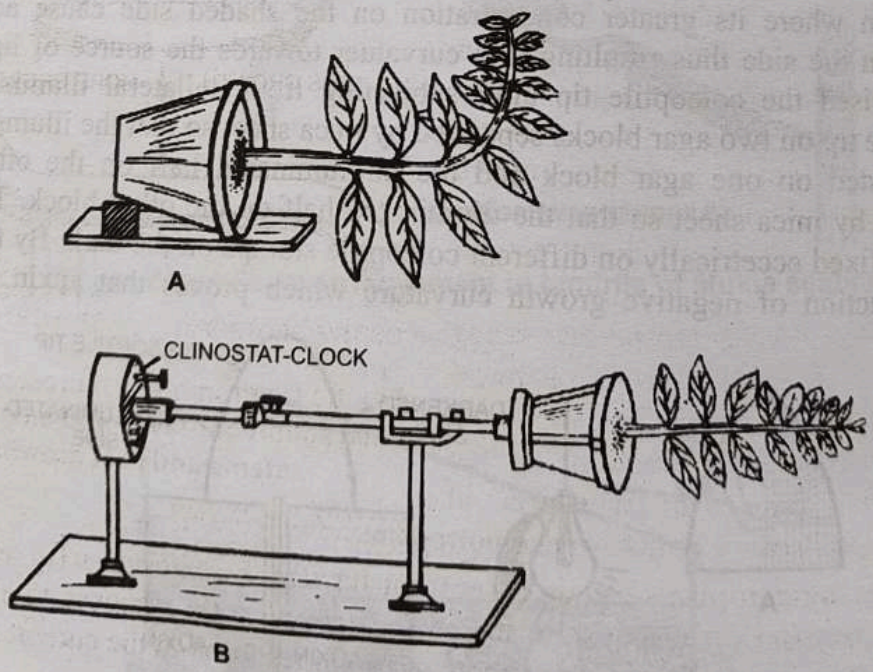


Fig. .7 : Clinostat

The orientation of different plant organs is due to one sided stimulation by the forces of gravity. By a instrument *''clinostat''* it has been seen that when the

unilateral effect of gravity is eliminated, no curvature is produced. The celinostat consists of a clock work which rotates a disc attached to the clock work by means of an axial-rod. A flower pot containing a seedling is fixed to disc and the apparatus is placed in a horizontal direction and the clock work started. The disck along with seedling rotates. Thus all sides of plants successively come to receive the geotropic stimulus equally. In this case no curvature of root or shoot is produced.

Geotropism mostly has been studied in roots. The stem also shows geotropic reactions but in opposite direction.

The mechanism of the preparation of the geotropic stimulus by plant may be explained by the *auxins theory*. According to this theory, the gravitational response is brought by some regulation hormone or auxin. The auxin is produced in the root tip and the stem tip and diffuses to the zone of elongation. The different response of the root and the stem of gravity are due to the difference in the optimum concentration of the auxin for stem growth is higher than for the growth of root. The increased concentration of the auxin on the lower side of stem, therefore, promotes growth of that side and cause the system to bear upwards. The optimum concentration of the auxin for root growth is much lower. The increased concentration of the auxin for the lower side of the root exceeds that optimum and therefore, retards the growth of that side with the result that the bending is down words. In present day this theory has been almost accepted.

(v) Chemotropism

The movement of plant organs induced by the presence of certain chemical substances is spoken as *Chemotropism e.g.,* movement of sensitive hairs in *Drosera,* folding of lamina in *Dionea,* folding of lamina in *Dionea,* closing of lid of pitcher in *Nepenthese* etc., on coming in contact with nitrogenous food. Hyphae of many fungi show positive chemotropism towards sugars etc. Pollen tubers are also positively chemotropism their growth through the style and later towards the egg apparatus in angiosperms being apparently directed by chemical substance present in style and produced and a result of disinteraction of the synergids Penetration of haustoria in *Cuscuta* etc. is also an example of chemotropism.

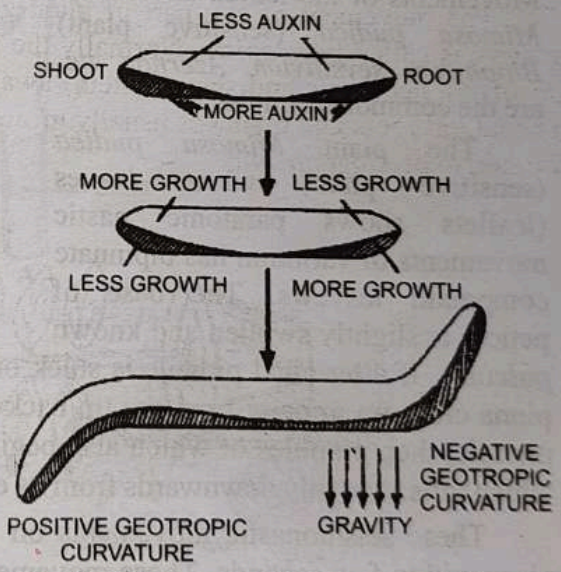


Fig. 8 : Diagrammatic representation of interaction of gravity and auxin on the stems and root growth

Besides these tropisms certain other tropisms *like thermotropism* (in response to heat), *tramptropism* (in response to injuiry), *electropism* (in response to electricity) *aerotopism* (in response to air) and *rheotropism* (in response to the current of water), which are of little less importance.

Nastic Movements

(*Paratonic curvature movement of variations*)

The nastic movements are governed by external stimuli but the direction of movement are not determined by the direction of stimulus. These movements are independent to the direction of stimulus and may occur in any direction. Nastic movements are mostly exhibited by flat dorsiventral organs leaves and petals. The following kinds of nastic movements are common :

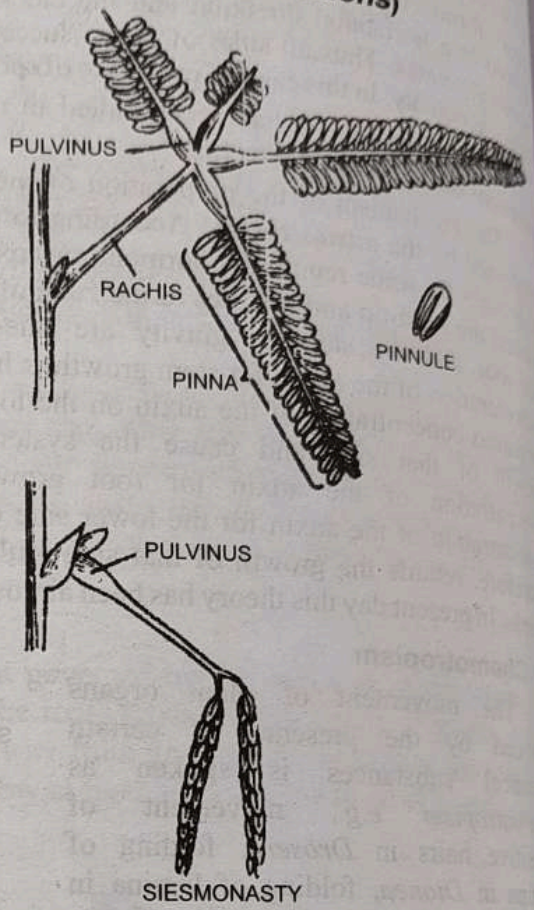


Fig. 9 : *Mimosa pudica* branch showing seismonastic movement

(i) Seismonastic movements

These movements brought about by mechanical stimuli such contact with a foreign body, wind, rain drops etc. are called *seismonastry.* Movements of the leaves (leaflets of *Mimosa pudica* (sensitive plant) *Biophytum seysitivum, Azerhoa* etc. are the common examples.

The plant *Mimosa pudica* (sensitive plant) where leaves (leaflets shows paratonic nastic movements of variation has bipinnate compound leavews. The base of petiole is slightly swollen and known *pulvinus.* If a terminal pinnule is stuck or touched, all the plnnule of the stimulated pinna close up in pairs from the tip backwards. The stimulus the passes to the other pinnule, then pinnules of which also begin to close up from the base of main petiole which falls suddenly downwards from its erect position.

These seismonastic movements on the sensitive plants are very rapid, taking place within few seconds. These movements are caused by differential loss of turgor on the two sides of pulvinus. The lower half a pulvinus is made up of thin walled cells with large inter-cellular spaces and in the upper half the cells with comparatively thick walled and intercellular spaces are fewer.

In recent days it is supposed that the transmission of stimulus is brought about by a hormone which is produced in a stimulated part and travels to the pulvinus xylem.

(ii) Thermonastic Movements

These movements are brought about by the differences in temperature, opening and closing of flowers and leaves and different temperatures are common examples of it *e.g.*, flowers of *Tulpia,* leaves of *Colchicum, Oxalis ansmore* etc.

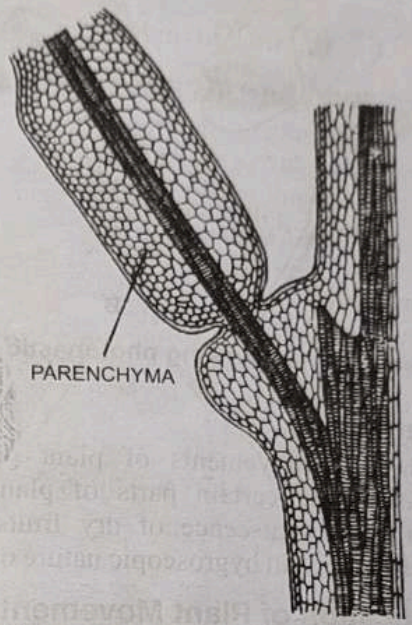


Fig. 10 : *Mimosa pudica*-section through pulvinus

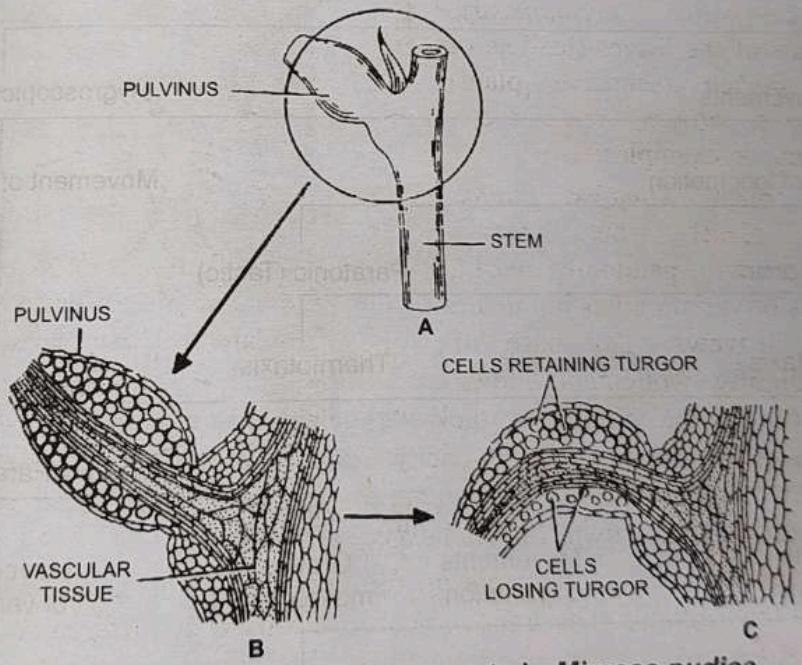


Fig. 11 : Seismonastic movements in *Mimosa pudica*.

(iii) Nyctinastic movements Or (Sleeping movements)

These movements are induced by alternation of day and night and are called *nyctinastic or nyctitropism or sleep movement.* Leaves and flowers are markedly affected by nyctinasty. The movements are effected both by light and temperature.

These movements are quite common in various plants of family chenopodiaceae and portuleceae. The leaves of flowers of them drop in the night and assume their normal shape in morning again.

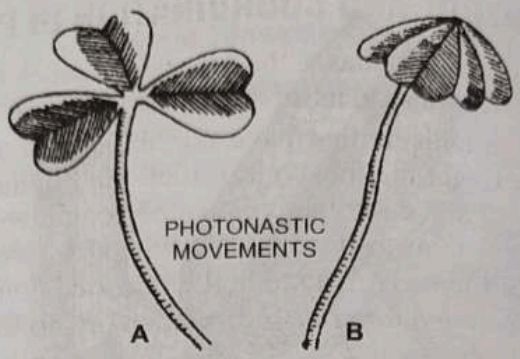


Fig. 12 : Oxalis leaves showing photonastic movements.

Hygroscopic Movements

These are the mechanical movements of plant organs. In this type the movements are performed by the certain parts of plants, like the brusting of sporangia in ferns, rupture and dehiscence of dry fruits etc. These movements normally brought about to difference in hygroscopic nature of the tissue.

Chart Showing Classification of Plant Movements