



M.U.C WOMEN'S COLLEGE

BURDWAN



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NAME :- TITLI DAS

ROLL NO. :- 244

UNIVERSITY ROLL NO. :- 190611610014

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INTRODUCTION

In gymnosperms, the ovule is not contained in a capsule, but exposed on the surface of a dedicated support organ, such as the scale of a cone so that the penetration of pollen tissue is unnecessary. Two main modes of fertilization are found in gymnosperms. Sperms and synergids have mobile sperm that swim directly to the egg inside the ovule, where as synergids and spermatophytes have sperm that are unable to swim but are conveyed to the egg along a pollen tube.

The study of Pollination brings together many disciplines, such as botany, biochemistry, entomology, and ecology. It is important in botany, agriculture, and ecology. It is important in botany, agriculture, and ecology. It is important in botany, agriculture, and ecology. It is important in botany, agriculture, and ecology. The study of pollination by insects is known as entomology.

POLLINATION

Pollination is the process of transfer of pollen grains from an anther to the stigma of a flower. In gymnosperms, the pollen grains are directly transferred to the micropyle of the naked ovule. Therefore, the first obvious requisite for pollination is the opening of anther sacs to release the pollen grains (anther dehiscence).

Anther Dehiscence: → Maturation and desiccation of anther tissue and essential for anther dehiscence.

Ripe anthers dehisc over a considerable range of temperatures and humidity. The dehiscence of anther involves two distinct processes: (a) Swelling and development thickened mechanical layers & differentiation in its wall. In a mature anther these layers are present all around the lobe except at special area, called stium. (b) In the second process, which comes into operation at the time of actual dehiscence, the mechanical layers become active and develop forces aiding in the rupture of anther wall along the stium.

Pollen Transfer: → Based on the destination of pollen grains, two types of pollination are recognised. When pollen grains are transferred from an anther to the stigma of the same flower, the process is called self-pollination or autogamy. If they are transferred to the stigma of another flower, cross-pollination is said to have taken place. Cross-pollination is

further classified depending on whether the pollination has occurred between two flowers on the same plant (autogamy) or between two flowers on different plants (xenogamy).

From a geneticist's viewpoint xenogamy is similar to self-pollination because all the flowers on a plant are normally genetically identical. To him cross-pollination make sense only if two different plants, either of the same species or different species are involved in the process. However, pollination ecologists plead that since xenogamy and xenogamy both require similar ecological factors for pollen transfer they should be considered under one category. Unless mentioned otherwise, we shall follow the classification as accepted by ecologist.

Types of Pollination :- Pollination is of two types:

- i) Self-Pollination.
- ii) Cross-Pollination.

Self-Pollination or Homogamy or Autogamy:-

When the pollen grains are transferred from an anther to the stigma of the same flower, the process is called self-pollination. Viz. Commelina benghalensis of Commelinaceae, Agave americana of Papaveraceae, Mimabilis jalapa of Nyctaginaceae etc.

On the other hand, the process of transfer of pollen grains from anther of one flower (unisexual or bisexual) occurring on the same plant is called autogamy.
From the biological point of view, little

difference exists between autogamy and geitonogamy as all the flowers of a plant are genetically same.

Under certain environmental conditions the plants which commonly form cleistogamous flowers start producing cleistogamous flowers. In Timbuctu, one of the world's hottest desert regions, the ground temperature throughout the year is $70-80^{\circ}\text{C}$, and it gradually decreases to 40°C at man's height (170 cm). On the part of the world the trees and shrubs of man's height on one area insect pollination whereas the ground flora, due to lack of any insect in the area, are self-pollinated. The latter is promoted by cleistogamy. The species of Hydrophyllum growing in the middle climates are pollinated by honeybees, whereas in the spiced subtropical region of Timbuctu the anthers dehisce while flower flowers are still closed and thus effect self-pollination.

Cross-pollination on Allogamy \rightarrow When the pollen grains are transferred from an anther of one flower to the stigma of another flower borne on different plants of same or different species, the process is

called cross-pollination. Viz. Nichelia champaca of Mangrove forest, Leucas sibirica of Lamiaceae etc.

↑ The cross-pollination taking place between two different plants of the same species is called xenogamy and between two different species is called hybridism.

Contrivances for Self-pollination :- Self-pollination occurs and never in unisexual ones. These are several devices which ensure self-

pollination.

Chastogamy :- Some plants produce small and closed bisexual flowers, in addition to normal flowers. These small flowers remain either on or under the ground and never open and so self-pollination is obvious. These flowers are said to be cleistogamous or cleistogamous, e.g. Commelina benghalensis of Commelinaceae, Sundew, Shorea burmerii of Sesuvaceae, Oxalis corniculata of Oxalidaceae, Impatiens balsamina of Balanitaceae, Polygala polygama of Polygalaceae etc.

It is of two types:

Obligate or habitual cleistogamy :- The flowers are typically cleistogamous and never

open, e.g. small underground flowers of Commelina benghalensis of Commelinaceae etc.

b) Facultative on pseudo-epistogamy: The flowers remain open for a short period of

time and they become closed permanently, e.g., sunflower, Brassica humilis of Brassicaceae, Oralis anniculata of Crocidaceae, Portulaca elevaria of Portulacaceae etc.

2) Homogamy: When anthers and stigmas become matured almost at the same time, the self-pollination takes place. This condition is called homogamy.

The chasmogamous flowers (i.e., the flowers normally open during ontogeny) are commonly cross-pollinated, but due to failure of cross-pollination of the following processes:

a) The style and filament get spirally curled, e.g., Chenopodium viscosum of Verberaceae, Mimulus jalapa of Nyctaginiaceae etc.

b) The style elongates to receive the pollen, e.g., Gonolobus florida of Rubiaceae.

c) The stigma either contracts or bends to come in close contact with the anthers, e.g., Gnecia subinaequivalis of Filicesae.

The stigma curls back to reach the anthers, e.g., sunflower, Helianthus annuus of Asteraceae etc.

Contrivance for cross-pollination → There are several devices which ensure cross-pollination

Pieling on unisexuality → When unisexual (dioecious) flowers pistillate or female flowers are borne on the different plants of the same species (dioecious plant), then the cross-pollination is a must e.g., Bryonia dioica and Charikantla's dioica of Cucurbitaceae; Sania papaya of Saniceae; Bonassia phyllifera of Anacardaceae etc.

In monoecious plants, however, geitonogamy may take place e.g., maize, Zea mays of Poaceae; ground Cucurbita maxima of Cucurbitaceae etc.

Dieckogamy → In some bisexual flowers, the stamens and carpels do not mature at the same time, thereby the self-pollination becomes hindered. It is of two types:

Protandry or protogyny → The maturing of a flower mature earlier than the carpels, e.g., Leonurus

sp. of Lamiaceae (Labiatae), Helianthus annuus of Asteraceae (Compositae) Hibiscus sp. of Malvaceae etc.

Protogyny or protogyny: The carpels of a flower mature earlier than the anthers, e.g. Magnolia grandiflora and Melaleuca champion of Myrtaceae, Podilanthus tithymaloides and Poinsettia pulcherrima of Euphorbiaceae etc.

Self-sterility or incompatibility: In this condition, the pollen grains are not able to fertilise the ovule of the same flower as they failed to germinate on the stigma, e.g. Rosa donate of Rosaceae, a few fruit trees of Rosaceae, Solanum tuberosum of Solanaceae, Passiflora sp. of Passifloraceae etc.

Hexangy: In some flowers, due to some physical barriers between anther and style, the pollination becomes impossible. In Orchids and members of Asclepiadaceae like Cathartus procerus, where the pollen are aggregated in pollenia, the pollination is completely depends on the agency of the insects. Due to the extreme anthers in Sporobolus superba of Liliaceae, the pollen borne out of reach of its own stigma.

Heteromorphism: In some plants, the flowers ^{are} of two (monoplic) or three (trimorphic) different having anthers and stigmas developed at different levels. The di or trimorphism usually involves heterostyly (i.e. styles of

different types) and heterostyly (i.e. styles of different lengths). Thus, the cross-pollination takes place between stamens and stigmas of same length.

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The dimorphism is found in Primula sinensis of Primulaceae, where one type again having long stamen and a short style and the other having short stamen and a long style. It is also found in Polygonum orientale and Fagopyrum esculentum of Polygonaceae, Biophytum sensitivum of Oralidaceae, etc.

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The trimorphism is found in Lythrum salicaria of Lythraceae, where there are three different forms of flowers having short, long and medium sized stamens and styles. It is also found in Oralis corniculata and Avenhaea parviflora of Oralidaceae, Woodfordia floribunda of Lythraceae etc.

Agents For Cross-Pollination

Different agents can transfer pollen grains from anther of one flower to the stigma of other flowers. The agents are: Wind (anemophily), water (hydrophily), insects (entomophily), slugs, snails and squirts (malacoophily), birds (ornithophily), bat (chiropterophily). There are different types of pollination based on the pollinating agents:

1) Anemophily or Anemogamy :- The pollination with the help of wind is called anemophily. The cross-

pollinated plants produce enormous amounts of pollen grains. The pollen grains are small, smooth, dry and light in weight. Pollens of such plants are blown off at a distance more than 1000 km. A single plant of Monardaalis aurea has been estimated to produce more than 150 crores of pollen grains. The pollen grains of Pinus (Gymnosperm) are winged and help in wind pollination. In grasses, the flowers may be borne on long stalks situated much above the leaves and the anthers are versatile, thereby the anthers can oscillate in all direction at the tip of the filament. On the other hand, the flowers have adequate device to catch the air-borne pollen grains. In grasses, the stigma is usually large and feathery, which helps to catch the pollen grains. In Typha, the stigma is brush-like which helps to catch more pollen grains.

2) Hydrophily or Hydrogamy :- The pollination with the help of water is called hydrophily. It is of two types: a) Hypohydrogamy and b) Epiphydrogamy.

a) Hypohydrogamy :- When the pollination takes place inside the water, it is called hypohydrogamy.

e.g. Najas sp., Ceratophyllum sp. etc.

b) Epiphydrogamy :- When pollination takes place on the water

surface, it is called Entomogamy; e.g., Vallisneria spiralis (sibbon weed). In Vallisneria, the flowers are borne under water. After maturation, the pisillate flowers are brought to the surface by their long stalk and form a cup-like depression. The male flowers get detached from the parent plant and float on the surface of water. If male flower gets lodged into the depression, pollination occurs. After pollination, the elongated stalk of the pisillate flower undergoes spiral coiling, thereby it again comes under the water.

3) Zoophily on Zoogamy or Zooidiophily :→ When pollination takes place with the help of animals, it is called Zoophily. It is of the following types:

1) Entomophily or entomogamy :→ When pollination takes place with the help of insects, it is called entomophily. The insects that help in pollination are bees, flies, beetles etc. The flowers which open during sunrise and are generally brightly coloured, acting as flag attractants for attracting insects. But the flowers these open after sunset are white in colour, thus become visible in night. In addition to colour, other devices to attract the insects are smell and/or nectar. The pollen grains are larger in size, the ovine is pitted, spiny etc., so they can be adhered firmly on the

stery stigma. Approximately, 80% of the pollination done by the insects is carried by bees.

b) Malesophily or malacophily: → When pollination takes place with

snails, squinckles etc.. It is called malesophily. During their visit from one tree to other, the slugs help in pollination. Like water, snails and squinckles also pollinate some avoid flowers.

c) Ornithophily or ornithogamy: → When pollination takes place with the body of birds, it is called Ornithophily. The ornithophilous flowers are very large and showy, these secrete profuse nectars within them, thereby some birds get attracted. Ornithophily is visible in some flowers like

Bignonia spectabilis of Bignoniaceae, Sholitzia nigra of Musaceae, Gutta monostroma of Fabaceae, Bombax ciba of Bombacaceae etc.

d) Chiropterophily or chiropterogamy: → When pollination takes place with the help of bats,

it is called chiropterophily. The flowers of Bombax ciba of Bombacaceae, Anthonaphalus codamba of Rubiaceae etc., are pollinated by bat.

ADVANTAGES AND DISADVANTAGES OF SELF AND CROSS-POLLINATION

Several advantages and disadvantages are there in nature in both self and cross-pollination:

Advantages of Self-Pollination:

- 1) The purity of the race is maintained through self-pollination.
- 2) The wastage of pollen grain is negligible.
- 3) Chances of failure of pollination are very less.

Disadvantages of Self-Pollination:

- 1) The production of new species and varieties is inhibited.
- 2) Also to ~~control~~ continued self-pollination for several generations. The progeny becomes weak.

Advantages of Cross-Pollination:

- 1) Cross-pollination is useful in improving the crop and also for production of new varieties of different crops like fruits, vegetables etc.
- 2) The offsprings become more healthy and strong.
- 3) The production of more viable seeds is increased.
- 4) The plants are better adapted in the nature.

Disadvantages of Cross-Pollination:

- i) Pollination is uncertain, because it depends on external agencies like wind, insects, water etc.
- ii) The wastage of pollen is much more as it depends on external agents. Wastage of pollen is more in anemophily (wind pollination) than other types.
- iii) The wastage of energy is much more.

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