Course- B.Sc.Part-I Botany Subsidiary

PAPER-I

Topic - Life cycle of *Puccinia graminis* (Fungi)

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Life cycle:

The life cycle of rust is completed on two host plants in India and hence the name is Heteroecious rust(Autoecious if completed on one host Plasmopara viticola-Rust of Linseed).

The life cycle is completed in following stages.

Stage 0: Pycnium bearing spermatia and receptive hyphae- On Barberry

Stage I: Aecium bearing aeciospores,- On Barberry

Stage II: Uredinium bearing urediniospores.- On Wheat(Source of Primary infection)

Stage III: Telium bearing teleospores- On Wheat(Source of Secondary infection

Stage IV: Basidiospores- On soil.

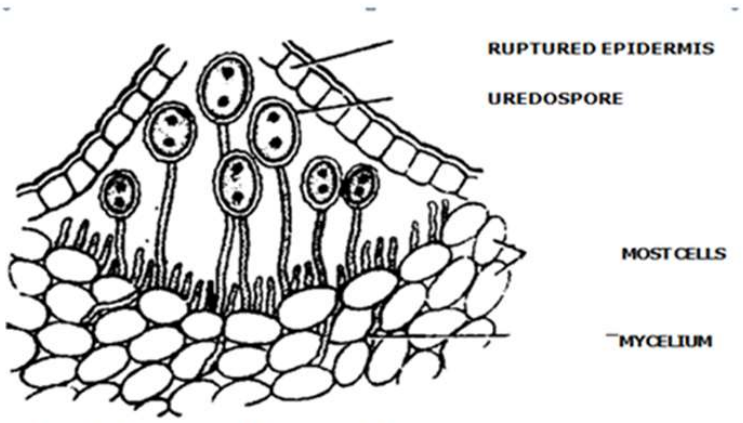
Most of the stage of the life cycle is spent as dikaryotic mycelium(two nuclei in one compartment) like in Uredo stage, Teleuto stage, Aecial stage.However Monokaryotic stage(One nucleus in one compartment) is noticed in Basidial stage and in Pycnial stage.

Sexuality in Rust

While Basidiospores and pycnium producing spermatia and receptive hyphae are uninucleate, it was Craigie (1927) who discovered that Pycnium is the gametic stage bearing sex cells which are self-sterile.It is the stage where plasmogamy and dikaryotisation take place when spermatia and receptive hyphae of the compatible mating type come in contact.

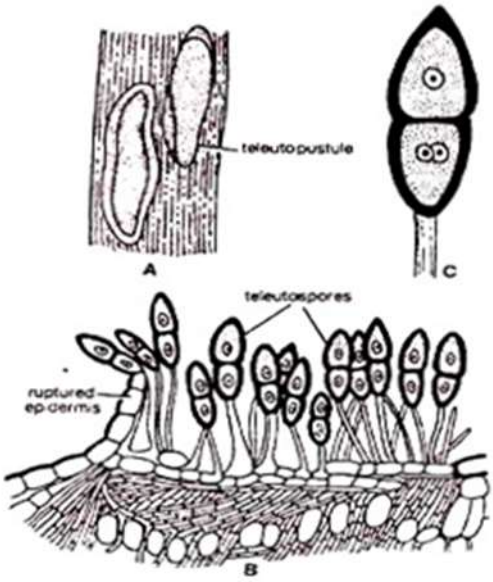
Disease Cycle

Aeciospore travelling through air coming from the secondary host is the main cause of Primary infection as they form the Primary inoculum. After infection they give rise to Uredosori which contains bicelled uredospore having binucleate condition. Large number of uredospores formed act as Primary inoculum and is the main cause of endemic spread of infection .



T.S. of affected leaf of wheat showing uredospores.

As the host matures the uredosori turns into teleutosori. The teleutosori contains two celled teleutospore each containing two nuclei(Dikaryon).



(A–C). *Puccinia graminis* : (A) Teteutopustule on wheat. (B) Vertical section of leaf passing through teleutosorus; (C) A single teleutospore

Germination of teleutospore

Two nuclei in each cell of the teleutospore fuse to complete dikaryotization .A diploid nuclei is thus created and this is the stage of sexual reproduction in rust fungi.After fusion meiotic division occur immediately giving rise to four nuclei.Two of the nuclei are of plus type and two of minus type. All the four nuclei is transferred to a mycelial structure emerging from each teleutospore and is called as Promycelium or Baidium. Septation occurs in basidium each unit containing one nucleus. The haploid nucleus from each promycelium cell migrates

into this developing spore cell through its respective sterigma. Thus, at the tip of each sterigma, a minute spore is formed.

This spore is called basidiospore . Each cell of promycelium produces a single basidiospore. Thus, from a single cell of teleutospore four haploid, unicellular, uninucleate basidiospores are formed. Two, out of the four telutospore basidiospores are of '+' strain and the other two of strain.

Stages on Barberry Plant:

The basidiospore remains in the soil for couple of months and then are blown away to foot of the hill to infect the alternate host Barberry.The basidiospores, which fall over the upper surface of barberry leaf start germinating soon. They germinate by giving out a germ tube which penetrates through the epidermis to develop Pycnidial stage.

Spermogonial or Pycnidial Stage:

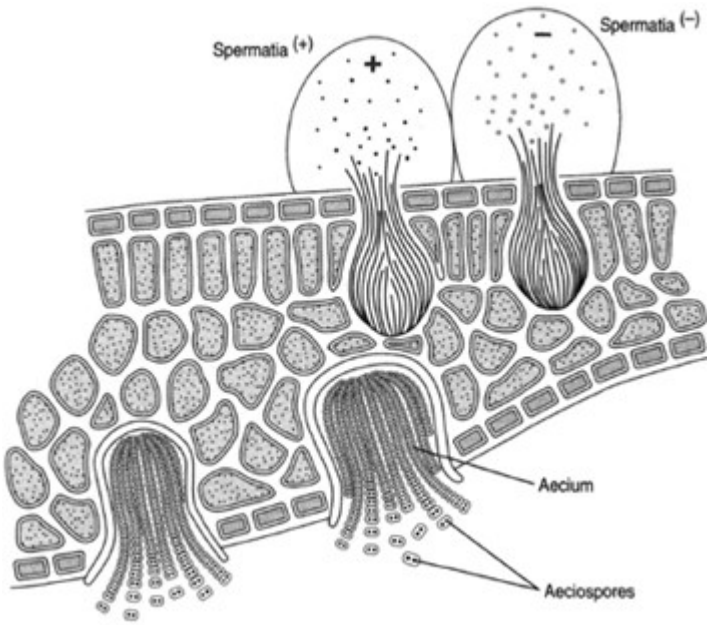
This stage is also known as Pycnial or spermatial stage. After about four days of the infection, the haplomycelium collects and forms dense mats both beneath the upper and lower epidermis. The mycelial mats beneath the upper epidermis are known as primordium of spermogonium while the mats beneath the lower epidermis are known as primordium of aecidium or protoaecidium.In 7 to 10 days after infection, each primordium of spermogonia matures into a small flask shaped structure called spermogonium or pvcnidium. The pycnidia appear as minute yellowish specks on the upper surface of the leaf .

Its wall consists of three kinds of hyphae:

(i) Periphysis: The ostiole is surrounded at the fringe by the long, delicate, sterile hyphae known as periphysis. They develop near the ostiole from the spermogonial wall and project from the ostiole.

(ii) Flexuous or Receptive Hyphae: They also arise from the lateral wall of the spermogonium. They are slender, delicate, cylindrical, septate, simple, branched or un-branched with blunt ends. They are present amidst periphysis and sometimes it is difficult to distinguish between the two.

(iii) Spermatiophores or Pycnidiophores: These are slender, short, vertical, uninucleate hyphae which arise form the base of the spermogcnium . Each spermatiophore (or sporophore) produces several small uninucleate spermatia or pycnidiospores at its tip by abstraction method



Pycnial cup of Puccinia

The spermatia are unicellular, small, oval to spherical, hyaline and smooth walled structures. The spermatia fill the spermogonial cavity and are exuded from the ostiole in a droplet of nectar, which is a thick, sticky, sweet liquid.

According to Craigie (1927) and Butler (1927) the spermatia function as male cell while receptive or flexuous hyphe represent the female sex organs . The spermatia may be '+' or in their sexual nature depend r.g upon the mycelium, produced by the basidiospores '+' or '-'. The insects are attracted by this necter. The spermatia are dispersed from one spermogonium to another spermogonium on the same leaf – this necter leaf to another leaf. As a result, the '-' spermatia are transferred to '+' receptive hyphae and are transferred to receptive hyphae. Now the spermatization takes place. The spermatia of strain come in contact with the tip of the receptive hyphae of opposite strain. The intervening wall at the one stain of contact between these two dissolves and the spermatium nucleus passes downwards through septal pores and form a bi-nucleate cell. This pair of nuclei of opposite strains is called a dikaryon and this process is called dikaryotization.

Aecial or Aecidial Stage:

The haplomycelium forms the primordium of aecidium or protoaecidium beneath the lower epidermis. The further development of protoaecidium into aecidium takes place only after the dikaryotization.

The spermatial nucleus (male nucleus) by mitotic division forms a second male nucleus, which moves to the next cell, through septal perforation. In this way the male nuclei produced by successive mitotic divisions pass down and all the cells of primary mycelium are dikaryotized.The dikaryotic basal cells of the protoaecidium arrange themselves vertically beneath the lower epidermis and are called as sporophores. Each bi-nucleate basal cell then cuts off a chain of bi-nucleate cells in basipetal succession on the side towards the lower epidermis of the host.

These cells are the aecidiospore mother cells . These cells further divide transversely to form a large cell and a small cell. The large cell develops into aecidiospore while the small cell remains sterile and is known as disjunctor or intercalary cell. The latter dissolves and sets free the aeciospores.With the development of the aeciospores some of the bassal cells lying at the periphery of protoaecidium mature into a one-celled thick protective layer called peridium.

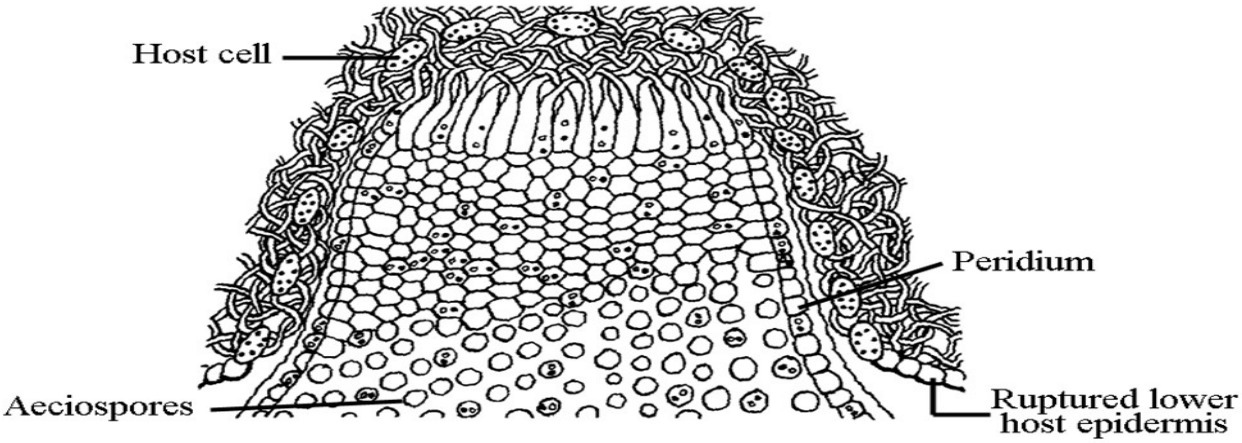


Fig: Section through aecium showing aeciospores.

This entire structure is cup shaped and is known as aecium. The developing aeciospores rupture the peridium by exerting a pressure on it. Thus, the aeciospores are liberated. They are unicellular, polyhedral, thin walled, bi-nucleate and orange yellow coloured.

The aeciospores are disseminated by wind. They are capable of immediate germination but cannot infect barberry plants. Falling on suitable host i.e., what leaf they germinate by producing a germ tube or primary hyphae.

The further development of the germ tube is similar as described in the uredinal stage and ultimately the dikaryotic mycelium is produced. This is the mycelium which produces the uredospore's and later the teleutospores on wheat. In this way, the life cycle of Puccinia graminis is completed.The genera of the rust fungi are identified by the structure of their teliospores. There are five families in the order. Family Pucciniaceae .