

Critical notes on some plant rusts III *)

By M. J. Thirumalachar & M. J. Narasimhan (Bangalore, India).

With 1 Textfig.

1. Notes on the genus *Kweilingia* Teng.

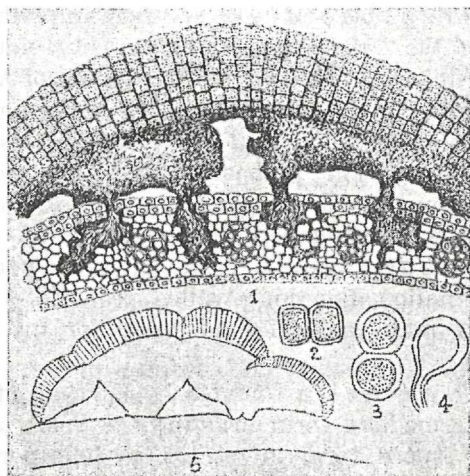
The genus *Kweilingia* was described as a rust genus by Teng (1940) based on *K. Bambusae* Teng on *Bambusa* sp. in China. The fungus was first described as *Chrysomyxa Bambusae* (Teng, 1938) and later made the type of the genus on account of the presence of the coloured teliospore walls and crustose habit of the sorus. The only spore form that has been described is what is stated to be the telial stage of the fungus. The telia are stated to be subepidermal, soon erumpent, confluent and crustose, waxy dark-brown, the teliospores being catenulate, with the chains laterally united, 1-celled, oblong or cuboid, with smooth brownish-walls, germinating typically by a four-celled basidium bearing globose or subglobose sporidia. In enumerating the rust fungi of China, Cummins and Ling (1950) include also *Kweilingia Bambusae* as a rust fungus.

Small portion of the type material of *Kweilingia Bambusae* became available through the kindness of Dr. George B. Cummins, Arthur Herbarium, Purdue University. The material was softened in glycerine alcohol and thin sections were cut and stained which enabled a morphological study of the fungus.

The fruiting bodies were black and crustose and compactly grouped. Observations of the developmental stages of the fungus in sections revealed that the young fruiting body at first arose within the host tissue and soon ruptured the overlying epidermis. In transverse sections the strands of coarse septate hyphae within the host tissue forming foot-like connections may be made out (Fig. 1). On emerging out of the host, the mycelium gets grouped into pulvinate to discoid fructifications. When they are in close proximity, several of these anastomosed with each other to form a continuous crust layer, with the basal foot-like mycelial strands penetrating the host at different places (Fig. 1). Sections through the fructifications revealed and inner sterile tissue and an outer hymenial layer which

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covered the exposed surface. The inner sterile tissue consisted of hyphal cells which were very closely grouped and gelatinise at maturity. The hymenium was composed of yellowish-brown, subglobose to cuboid probasidia which were developed in chains of 4 to 8 spores. The chains of probasidia showed lateral coalescence and were compactly grouped. In some of the teased preparations the presence of thick-walled cysts (Fig. 4) which resembled to some extent those of *Neotlyphula guianensis* Wakef. described by Martin where the cysts are considered to be of the nature of metamorphosed probasidia, were noticed.



Figs. 1—4. *Kucilingia Bambusae*. — 1. Section through the fruiting body showing the foot-like attachment within the host, sterile and hymenial layers $\times 100$; 2—3. young and mature probasidia $\times 225$; 4. cyst. $\times 225$; 5. fruiting body *Dicellomyces gloeosporus* (drawn from Olive 1945).

The formation of the septate 4-celled basidia has been observed in very few cases, though Teng in the study of the fresh material reported abundance of germinating spores. The basidia had collapsed and gelatinised following germination.

When the structure of the fructification is considered, there is a remarkable resemblance with the Dacryomycetous fungus *Dicellomyces gloeosporus* described by Olive (1945) on the bamboo *Arundinaria tecla* in the United States (Fig. 5). Here also the pulvinate to discoid fruiting bodies have blunt foot-like base in the host and show lateral anastomose with each other. The distribution of the sterile and the fertile layer in the fruiting body is similar to the fungus under study, though the hymenial layer is composed of a single layer of clavate to pyriform probasidia. Ger-

mination and formation of the basidium is however typical of the *Dacryomycetales*, while in the fungus under study it is typical of the *Auriculariales*.

From a consideration of the structure of the fructification given above, it is evident that *Kweilingia* is a member of the *Auriculariales* rather than *Uredinales*. The foot-like base into the host, and pulvinate fruiting bodies with inner sterile and outer fertile hymenial layer points out its relationship with the members of the *Auriculariales*.

In discussing the relationships of *Dicelomyces* Olive points out that the presence of persistent probasidia in the *Auriculariales* like *Iola* and *Herpobasidium* are very important in pointing out the origin of the *Uredinales*. Their parasitic nature on higher plants is also an important feature. The probasidia of *Kweilingia* are yellowish-brown, thick-walled and more of the nature of resting spores than in any other member of the *Auriculariales* or *Dacryomycetales* so far known. The probasidia are produced in basipetal catenations and grouped into crusts somewhat resembling the condition present in the rust genera like *Dasturella* Mundkur & Kheshw. and *Nothoravenelia* Diet. It is no wonder that from superficial examination, the thick-walled probasidia of the fungus (*Kweilingia*) may easily be mistaken for the teliospores of rusts.

The genus *Uredinella* founded by Couch (1937) has been shown to be intermediate form bridging the rusts and the *Septobasidiaceae*. The spore form is termed as teliospore by Couch similar to those present in rusts. The two species of *Uredinella* so far described are chiefly entomogenous fungi. *Kweilingia*, which is a plant parasite is more closely related to the rusts than any other member of the *Auriculariales*.

2. Status of the genus *Uraecium* Arthur.

The form genus *Uraecium* was founded by Arthur (1933) to accommodate uredinoid aecial stages of rusts on Gymnosperms and Angiosperms, whose telial connections are not known. The genus is stated to have the same status as other form-genera *Uredo*, *Caecoma*, *Aecidium* etc. In several brachy-forms of rusts, the secondary uredia are usually associated with the telia. The form-genus *Uraecium* differs from *Uredo* only in that the pycnia are associated with the former. Eventhough it is given the status of aecia (uredinoid aecia) on account of its sequence of development, it is structurally indistinguishable from *Uredo*. On the other hand, the form-genera such as *Aecidium*, *Caecoma*, *Uredo* etc. are separated on the basis of distinct morphological variations. If the

various species of *Uredo* that have been described are re-examined, several of them would be found to be associated with pycnia, so that they should be transferred from one imperfect form-genus to another, though there are no morphological differences. The maintenance of the form-genus *Uraecium* therefore seems superfluous since it is not based on differences in morphological features. For instance, repeating secondary aecia of rusts (in the absence of telial stage being known) are placed under *Aecidium* though they are not accompanied by pycnia. Even so, the well established form-genus *Uredo* can include rust species whose uredial stages are either found alone or accompanied by aecia. Ainsworth and Bisby (1950) treat *Uraecium* as a synonym of *Uredo*.

3. Function of cysts in the telial heads of *Ravenelia Hobsoni* Cke.

The occurrence of hyaline cysts subtending the teliospore heads are characteristic of all species of *Ravenelia*. While their real function has not been understood properly, their presence or absence has been employed in rust taxonomy. Rust genera like *Uromycladium* McAlp., *Cystomyces* Syd. and *Spumula* Mains also show characteristic cysts in the telial heads. The cysts usually are of the same number as the teliospores in the head, but in several species they are less in number. The cysts are hyaline, hygroscopic, and often burst away in water.

The developmental stages of the cysts in these genera indicate that they represent metamorphosed teliospores. In several species of *Uromycladium*, the cysts replace the teliospores in the cluster, indicating that it is a transformed spore. In the genus *Ravenelia*, the cyst and the teliospore are differentiated from the same mother cell, the lower cell developing into the cyst and the upper cell forming the teliospore.

In the study of the teliospore head of *Ravenelia Hobsoni* parasitising the leaves of *Pongamia glabra*, the developmental stages of the cysts were traced. The telial heads are borne on multicellular pedicels which were short and fragile. At maturity the telial head gets detached from the pedicel due to the deciduous nature of the stalks and partly due to the pressure of young telial heads developing beneath. There was no teliospore discharging mechanism in the fungus under study, similar to the condition reported in *Puccinia tumidipes* Peck by Pady (1948). In the latter rust the teliospore discharge is brought about by the hygroscopic nature and everting of the pedicels. In the mature sorus of *Ravenelia Hobsoni* the telial heads lie scattered as powdery mass, getting dispersed in wind currents.

In examining the rust collections made on several other hosts growing in the neighbourhood of the rusted *Pongamia glabra* plants, telial heads, identical in size and shape with that of *Ravenelia Hobsoni*, were found attached to the leaf surfaces by the flattened side of the spore-heads. The attachment was quite firm and the spore-heads could be dislodged only with pressure. The cysts were not evident, but when the material was moistened with water and examined, a thin pellicle fixing the spores to the substrata was noticed.

Glass plates which were moistened by atomising with water in the previous evening, were placed close to the rusted *Pongamia glabra* plants. The glass plates were kept in such a position as to face the wind current blowing across the rusted plants. The glass plates were taken the next morning and examined microscopically. There was heavy dew condensation on the glass plates (6×9 cm size) which had dried in the morning. Observation revealed that there were 5 to 15 telial heads attached on the four glass plates that were placed. When the spore heads come in contact with the moist surface, the cysts swell by absorbing the moisture and begin to gelatinise and burst away. On drying, the spore heads are firmly fixed to the substrata and further moistening do not dislodge them easily. It became evident that in *Ravenelia Hobsoni* the cysts help to get the spores fixed to new substrata. In case of autoecious rusts like *R. Hobsoni* this may help in the successful infection of the same host.

Gäumann and Dodge (1928) state „that the cysts in *Ravenelia* are filled with a viscid substance and burst away at maturity. Their function is not yet clear; possibly they serve for water storage or they facilitate the separation of the spores from the sporiferous hyphae or attach the spores to new substrate.“ In *Ravenelia Hobsoni* the last mentioned function, viz. attachment of the spores to new substrata is atleast one of the chief functions.

4. On *Hapalophragmiopsis ponderosum* (Syd. & Butl.) Thirumal.

The genus *Hapalophragmiopsis* was described by Thirumalachar (1950) for the gall forming rust on *Acacia leucophloea* Willd. which had previously been placed under *Hapalophragmium ponderosum* Syd. & Butl. The genus *Hapalophragmiopsis* was separated from *Hapalophragmium* Syd. on the basis of the presence of subepidermal pycnia in the former contrast to the subcuticular one in the latter. Subcuticular pycnia and uredinoid aecia for the genus *Hapalophragmium* Syd. were also first described by Thirumala-

char (1950) in *H. mysorensis* on *Derris Benthamia* which closely resembled the type of the genus *H. Derridis* Syd. on *Derris uliginosa* and the other closely related species *H. setulosum* (Pat.) Syd. and *H. pulchrum* (Racib.) Syd. also occurring on species of *Derris*. Opportunity to examine either the type or authentic specimens of these species became available while the senior author worked at the important Herbaria in U.S.A. and England.

It is a well known fact that when the type species of a rust genus is a hemi-form, the pycnial and aecial characters of the genus are taken from species which is most closely related to the type species. For example, in the genus *Skierka* Racib. the pycnia are unknown in the type species *S. Canarii* Racib. but were discovered in *S. Holwayi* Arthur and *S. cristata* (Syd.) Mains, where they were found to be subepidermal. When the pycnial stage was discovered for *S. robusta* Doidge by Thirumalachar (1946), they were found to conform to the same subepidermal type. Evenso, the finding of the subcuticular pycnia and uredinoid aecia in *Hapalophragmium mysorensis* which is closely related to *H. Derridis* the type of the genus filled, the gap in our knowledge of these two spore forms for the genus *Hapalophragmium*.

Recently, Venkatarayan (1951) transferred the rust fungus on *Acacia leucophloea* under *Triphragmium ponderosum* as a new combination, reducing both the genera *Hapalophragmium* Syd. and *Hapalophragmiopsis*. Thirumal. as synonyms of *Triphragmium*. While these mere book transfers would not evoke any interest, it would have been more profitable if he had an opportunity to examine large number of authentic specimens to derive a first hand knowledge of the group instead of quoting and misinterpreting old literature as a basis for these transfers. The concept of generic characters that one would derive by examination of authentic specimens is often more reliable than that obtained by a study of published descriptions.

The type of arrangement of cells in a multicellular teliospore is an important distinguishing character in separating rust genera. The genus *Puccinia* for example is separated from *Diorchidium* in the type of septation of the teliospore and the relation of the two cells of the spore with the pedicel. *Hapalophragmium* and *Triphragmium* have both 3-celled pedicellate teliospores, but in the former genus the odd cell is terminal, while in the latter, the odd cell is towards the base. In profusely quoting the details of spore characters from published works, Venkatarayan has failed to grasp this important difference between the two genera and has got mixed

up in giving details of germ pores in urediospores etc. Consequently all distinguishing characters are „undependable“ for him.

As regards the importance of subcuticular or subepidermal nature of pycnia in rust taxonomy, Venkatarayan makes some rambling statements, which is understandable because he had no opportunity to make any comparative studies on the pycnia in various rust genera. Thirumalachar & Cummins (1949) pointed out that the position of pycnia in relation to the epidermis in a genus, is a most reliable character, next in importance only to the teliospore characters. More detailed studies have been made by Cummins & Gopalakrishnan (1951) confirming the same features. This was based on an examination of numerous species covering most of the rust genera where the pycnial stage is known. The characters differentiating *Chaconia* Juel from *Chrysocelis* Lagerh. & Diet., *Scopella* Mains from *Maravalia* Arth. *Chrysella* Syd. from *Achroetium* Syd. are based on the subcuticular or subepidermal nature of the pycnia, since their teliospore characters are similar or identical. Even so, *Hapalophragmium* and *Hapalophragmiopsis* are distinguished on the basis of the presence of subcuticular pycnia in the former and subepidermal ones in the latter.

Venkatarayan has criticized the writer for using the suffix — *opsis* in naming the genus *Hapalophragmiopsis* and quotes International Rules of Nomenclature (Recommendations X (f) and XI (b) against its use. One would wish that he had studied these recommendations a little more carefully before making a mistake in setting out to criticize others. The Recommendation XI (b) advocates, to avoid giving a sub-genus the name of the genus to which it belongs, by adding the ending-*oides* or *-opsis*. Bisby (1945) gives the following example to illustrate this point; *Mycenopsis* should not be used as a sub-genus of *Mycena*, but preferably of some other genus like *Marasmius*. Even a casual perusal through mycological literature would show that in genera like *Phoma*, *Phomopsis*, *Oidium*, *Oidiopsis*, *Endomyces*, *Endomycopsis*, *Olpidium*, *Olpidiopsis*, *Triphragmium*, *Triphragmiopsis*, *Endophyllum*, *Endophylloides* and hundreds of others, the suffix-*oides* and *-opsis* are used to designate generic names also.

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Autor(en)/Author(s): Thirumalachar M. J., Narasimhan M. J.

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