

Sorus structure in *Cintractia axicola*, with Comments on the Status of related Genera

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Summary

The sorus structure of *Cintractia axicola*, the type of the genus, *Cintractia* Cornu was studied in detail and the chief differentiating characters listed. The development of the sorus radially around a columella with alternate sterile and fertile hyphal strands differentiating spores centripetally, results in an agglutinated spore mass traversed by radial strands of sterile hyphae. The outermost layers of spores are transformed into a sterile false membrane. The spores germinate by septate promycelium bearing lateral and terminal sporidia. The genus *Farysia* Racib. develops similarly, but the plane is vertical and not radial. The sterile hyphal strands attached at the base extending vertically and free at the apex, appear as a brush enclosing the spore mass.

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The genus *Anthracoidea* Bref., until recently considered as a synonym of *Cintractia*, has no resemblances with *Cintractia*. Its spore germination type is similar to *Ustilaginoidea* Speg. and further studies may show it to be synonymous.

Planetella Savile, established for *P. lironis* on *Carex* species is based on equatorial thickenings of the spore wall, with hyaline polar caps. This is not considered a distinguishing character, as many smut species have unequal wall thickening. Based on the sorus structure, *Planetella* is considered synonymous with *Sphacelotheca* deBary, and the new combination *S. lironis* (Savile) comb nov. is proposed.

The genus *Cintractia* was described by Cornu (1883) with *C. axicola* (Berk.) Cornu as type, on *Fimbristylis* sp., a scirpoid plant in Santo Domingo. The sori ranging from 3–5 mm in diameter are formed mostly at the base of the peduncles and pedicels and rarely in the spikelets. They are at first covered by a whitish false membrane composed of fungus cells, which flake away at maturity revealing an agglutinated black spore mass. Cornu described the sorus as being formed in a centripetal manner from a fertile stroma surrounding a central columella of host tissue.

Numerous species of *Cintractia* have been described, mostly on Cyperaceae. Ling (1950) and (1950a) made detailed studies of the genus *Cintractia*, with reference to *C. montagnei* (Tul.) Magn. and *C. axicola*. Savile (1952) studied the *Cintractia* species infecting the host genera *Carex*, *Kobresia*, and *Scirpus*. Fischer (1953) remarked that all valid species of *Cintractia* are on Cyperaceae and Juncaceae, and Fischer and Holton (1957) stated, "it is doubtful if any true species of *Cintractia* occur on the Gramineae". Of the many species that have been described on the Gramineae, all but *C. melinis* Zundel have been transferred to other genera.

Smut species parasitizing Cyperaceae, forming agglutinated spore masses have regularly been placed under *Cintractia*, which may be incorrect if the chief differentiating characteristics are taken into account. A study of the differentiating characters indicated the need of a restudy of *Cintractia* and related genera. Some of the results of these studies are presented here, along with comments on the status of some of the related genera.

Materials and Methods

Histological observations were made of freshly collected and of corresponding type material of infected pistillate flowers. The histology of the sorus structures were studied in free-hand and microtome sections, the latter prepared by the paraffin method. Microtome sections were made of dry specimen material presoaked twelve hours in water, and of fresh collections fixed in Karpechenko's modification of Navashin's fluid, dehydrated in tertiary butyl alcohol-dioxane, embedded in paraffin, cut with a rotary microtome, and stained with a modification of Conart's quadruple stain.

Results

Thirumalachar (1950) studied the sorus structure of several species of *Cintractia* including *C. axicola*. In the present study, the authors have confirmed these characters by examining species of related genera. The type of sorus development in *Cintractia*, whether in peduncle, pedicel, or the spikelet is the same, and conforms to the description given by Cornu (1883) which has been overlooked by later investigators. At first a central mound of stromatic tissue is organized at the base of the thalamus, or surrounding the peduncle or pedicel. This stromatic mass alternately differentiates fertile and sterile strands of hyphae in a radiating manner at right angles to the host tissue or the columella (Figs. 2, 3, 4). The fertile hyphae successively produce teliospores by gelatinization which are pushed outwards as new spores are formed within, resulting in a centripetal type of spore development (Figs. 3, 4). The sterile strands of hyphae elongate forming strands of thin-walled cells, which later become thick-walled and brown. Cornu's illustration of the sorus of *C. axicola* (Fig. 1) clearly shows

the sorus traversed by alternate groups of fertile and sterile hyphae formed around the central columella. The outermost layers of spores form a sterile false membrane composed of pale yellow to brown, thickened spores or hyphal cells.

Species of the genus *Farysia* Racib. also parasitize members of the Cyperaceae, and the spore mass is traversed by a brush-like structure which aids in spore dispersal. Thirumalachar (1950) pointed out that the type of development in *Cintractia* and *Farysia* was the same except for the plane of development. In *Cintractia* the development of the sterile and fertile strands of hyphae is radial and at right angles to the thalamus or columella (Figs. 2, 3, 4) while in *Farysia* the mound of stromatic tissue arises from the thalamus and the alternate groups of fertile and sterile hyphae develop upward (Fig. 6). At maturity, as the spores become dusty, the sterile hyphal strands extend out as elatiers. In both, the entire sorus is covered with a sterile false membrane and host tissue. In view of this close development, the question arises as to the feasibility of placing them under separate genera as is presently done. From gross differences in the external appearances of the sori of the two, it is considered advisable, for the present, to treat them as separate genera.

The teliospores of *C. axicola*, collected by the authors from several localities in India and the U.S.A. were germinated. The type of germination was as in *Ustilago* with septate promycelium bearing both lateral and terminal sporidia which budded off secondary sporidia, in succession (Fig. 5). This is the first record of germination in *C. axicola*, the type of the genus.

The genus *Anthracoidea* was first described by Brefeld in 1883, parasitizing ovaries of Cyperaceae. The genus was treated as a synonym of *Cintractia* by Dietel (1928) and accepted as such by all later workers. Kukkonen (1963) considered *Anthracoidea* as a distinct genus on the basis of teliospore germination studies and sorus morphology. He showed that *Anthracoidea* does not have the thick sterile stroma characteristic of *Cintractia* and that spore germination is unique in that the sporidia are formed on a two-celled promycelium by successive formations of short sterigmata and not by repeated budding. He considered that this placed the genus between Ustilaginaceae and Tilletiaceae. In the observation of the germination pattern with the successive formation of sterigmata producing terminal spores and the germination pattern resembling that of the hyphomycetous genus *Tritirachium*, the conclusion can be ascertained that if such a condition as found in *A. eleocharidis* Kukkonen is present in other species, *Anthracoidea* may be merged or placed near *Ustilaginoida* where a similar type of germination pattern is present. These considerations make it evident that *Anthracoidea* is totally different from *Cintractia*.

Planetella, established by Savile with the type *P. lironis* Savile parasitizing *Carex leiophylla* Mack, a member of the Cyperaceae, is a smut

genus differentiated by the character of the spore wall layer. The spores are formed centripetally as an agglutinated spore mass around a central columella of host tissue, covered by a false membrane and with no differentiation of fertile and sterile strands, as in *Cintractia*. These characters would have satisfied the earlier concepts of the genus *Cintractia*, but Savile noted that the spores were thickened internally along the equatorial region, giving the appearance of a planet with a darkened central region and hyaline polar region (Fig. 7, 8).

The unequal thickening of the wall layers on which the genus *Planetella* is based is not considered a valid character for differentiating genera. Kukkonen (1963) pointed out that cell wall thickening is a common character of several species of *Cintractia*. *Cintractia montagnei* (Tul.) Magn. and *C. scleriae-elatae* Thirum. have equatorially thickened walls with hyaline polar caps more prominent than in *Planetella lironis*, so spore wall thickening, the differentiating character for separating *Planetella*, is not valid. In sorus structure it is identical to *Sphacelotheca* under which it is transferred as a new combination.

Sphacelotheca lironis (Savile) Thirum. and Whitehead, comb. nov. Figs. 7–8.

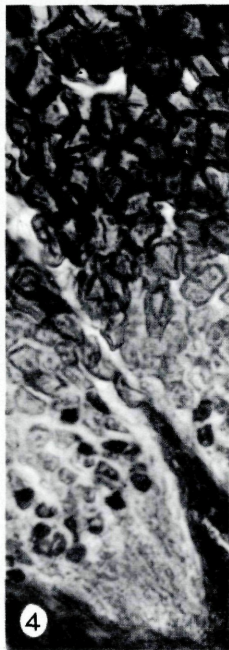
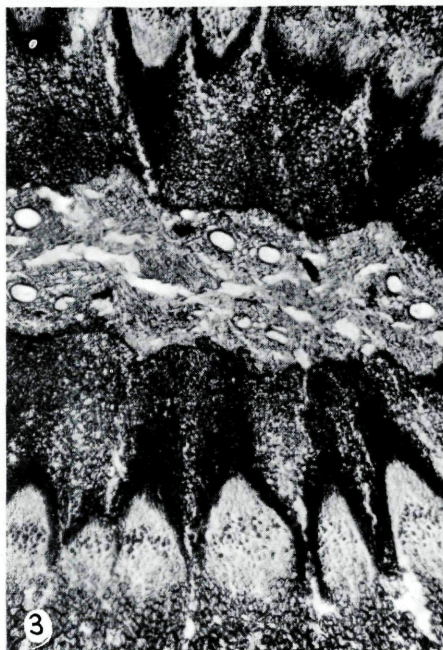
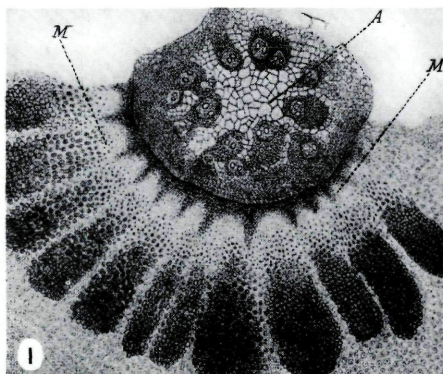
Planetella lironis Savile, Can. J. Bot. 29:324–328. 1951. (Basionym) Sori in the ovaries of *Carex leiophylla* Mack. Canada (Yukon).

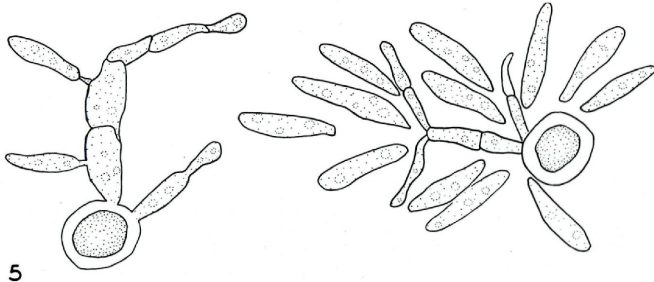
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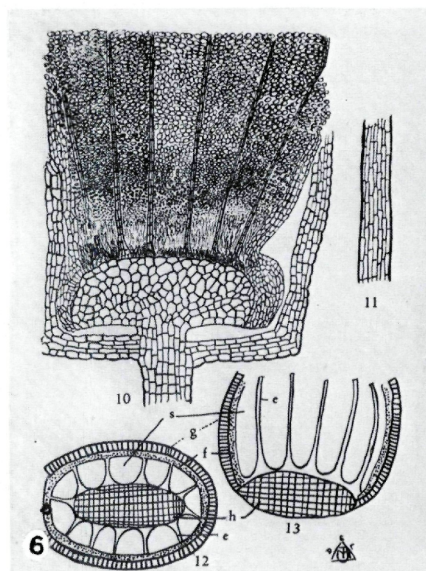
Figs. 1–4 *Cintractia axicola*. 1. Line drawing from Cornu, x 500. 2. Section through sorus showing columella of host tissue surrounded by fertile fungal stroma alternately differentiating fertile spores and bands of sterile hyphae, x 120. 3. Similiar section, x 240. 4. Enlarged portion showing centripetal formation of spores from a columella of fungal tissue dissected by a verticle strand of sterile hyphae, x 600.

Fig. 5. Spore germination of *Cintractia axicola*, x. 750. 6. Line drawing of *Farysia* from Thirumalachar, x 90. 7.–8. *Planetella lironis*. 7. Spores showing equatorial bands, x. 1000. 8. One spore showing an equatorial band and two looking down over the hyaline polar caps, x 1000.





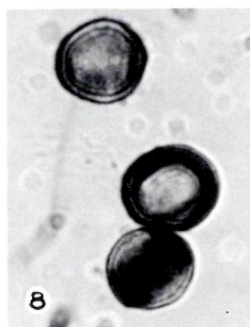
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