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APOTHECIAL DEVELOPMENT IN *COOKEINA TRICHOLOMA* WITH COMMENTS ON SOME RELATED SPECIES

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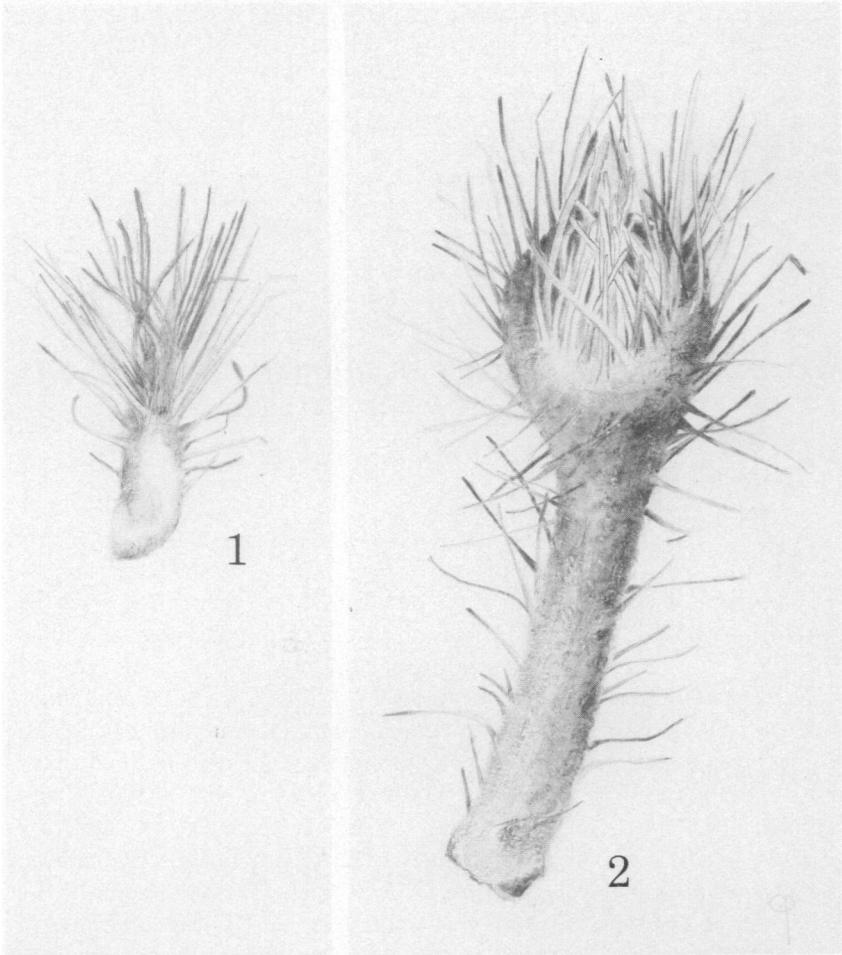
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The genus *Cookeina* is one of the best known and most often collected genera of tropical Discomycetes in the family Sarcoscyphaceae. The fairly large, often hairy apothecia attract the attention of most general collectors. The genus is distinct microscopically in its apothecial anatomy and the production of asci which mature simultaneously. The species of *Cookeina* are clearly delimited morphologically and have most recently been discussed by Denison (1967), Rifai (1968), and Eckblad (1968).

Despite the genus being well known, there are no observations on the general ontogeny of the apothecia. Over the past several years I have examined and studied a number of collections of *Cookeina tricholoma* (Mont.) Kuntze both in dried and in living condition. From this material I have been able to follow the development of apothecia from early stages to maturity.

Field collections of *Cookeina tricholoma* were used in this study. The most useful of these were made by Gerald and Sarah Kaplan in 1974 in San Germán, Puerto Rico. These collections are on the seed pods of *Hymenaea courbaril* L. These pods, which apparently provided adequate nutrients, supported from 10 to 15 apothecia at various stages of maturity. Voucher specimens are deposited at the Farlow Herbarium.

The ascocarps were studied when fresh. Material was also preserved in FAA, embedded in paraffin, sectioned on a rotary microtome at 10–13 μm , stained in iron hematoxylin and counter stained in Orange G in



FIGS. 1-2. *Cookeina tricholoma*. 1. Ascocarp as seen during the early prohymental phase. 2. Ascocarp at the late prohymental phase. $\times 20$.

clove oil. Some material was also stained in Giemsa (Rogers, 1965) for cytological observations.

The youngest stage observed was an ovoid to cylindrical hyphal mass surmounted by four to six hairs, which were composed of parallel hyphae laterally adherent to one another. Later stages (FIG. 1) show that hairs form successively at the apex while at the same time the primordial mass elongates. The distal portion becomes flattened and eventually becomes depressed (FIG. 2). The depression is surrounded by nu-

merous inwardly directed marginal hairs which cover a palisade layer of erect interwoven hyphae which line a plane or slightly depressed disc. An ascogenous system was not observed at this stage or in later stages. The short erect hyphae, which branch greatly and anastomose, can later be seen to be developing paraphyses.

In later stages (FIG. 3) the disc increases in diam through marginal growth and the stalk continues to elongate. The paraphyses continue to elongate and frequently fuse laterally. The disc becomes cupulate. The marginal hairs remain inwardly directed over the disc. The asci soon appear. They arise from thin vegetative hyphae which are not visibly differentiated from the other hyphae in the medullary area. They have very thin hyphal bases and seem to lack discernible croziers. The bases of the asci are variously modified and may become quite long. The disc expands to produce an open more-or-less shallow cup (FIG. 4). At maturity the marginal hairs no longer cover the hymenium.

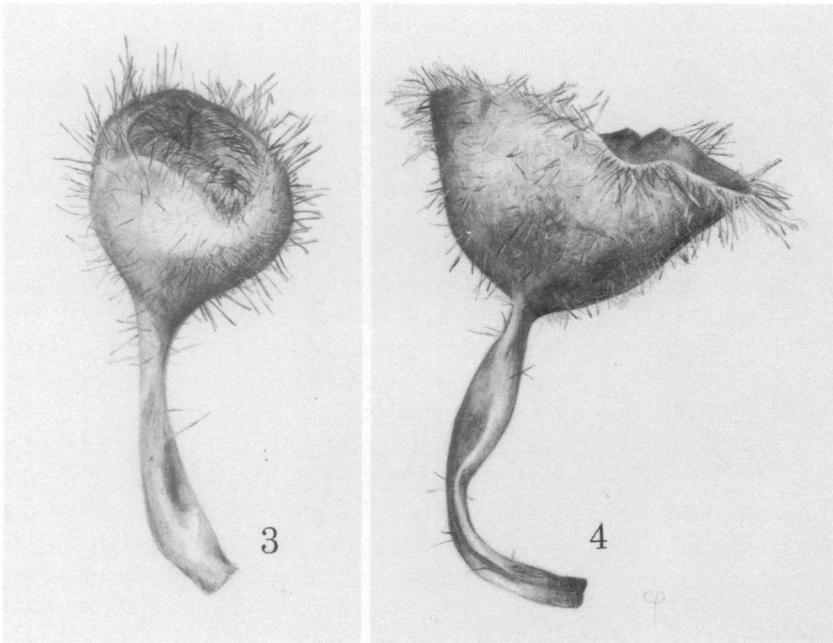
No meiotic apparatus was observed, however, the young ascospores are first uninucleate and then through apparent simultaneous mitotic divisions become binucleate. During later stages the mitotic divisions within the spores continue. Ascospores ultimately become multinucleate.

The lack of young primordia of *Cookeina tricholoma* prevents determining unequivocally the developmental sequence in van Brummelen's (1968) system. It appears, however, that *C. tricholoma* may follow a paragymnohymenial developmental sequence.

Detailed studies of early developmental stages have been carried out in no other member of the Sarcoscyphineae. In *Cookeina venezuelae* (Berk.) Seaver from Guadeloupe I have observed the same sequence as outlined for *C. tricholoma*. *Cookeina venezuelae* differs in its lack of hairs.

As previously pointed out (Pfister, 1974) there may be a fundamental difference in the mode of development in *Cookeina institia* (Berk. & Curt.) Kuntze. Boedijn (1933) stated that the hymenium in *C. institia* was covered by an imperforate membrane which at maturity ruptured to produce triangular marginal hairs. I have not observed this continuous membrane in specimens I have studied. The point needs verification through the study of fresh material.

Most, if not all, members of the Sarcoscyphaceae seem to exhibit exposed hymenia throughout their entire period of apothecial ontogenesis. *Cookeina venezuelae*, species of *Nanoscypha*, *Sarcoscypha*, *Microstoma*, and *Phillipsia* appear, on the basis of my general observations, to mature in this manner.



FIGS. 3-4. *Cookeina tricholoma*. 3. An ascocarp as it appears during the mesohymenial phase. 4. A mature ascocarp. $\times 3.5$.

The Sarcosomataceae, a second family of the Sarcoscyphineae, also have not been studied in detail. However, there are several cases in which cleistohymenial development has been noted or implied. These are in the monotypic genus *Chorioactis* (Heald and Wolf, 1910; Seaver, 1942) and in *Urnula* (Davidson, 1950).

In the case of *Chorioactis geaster* (Pk.) Kupf. the apothecium is closed until nearly the time of spore discharge. The apothecium at first forms a hollow clavate structure then apparently splits *Geaster*-like to expose the mature hymenium through pressure exerted by the swelling of the paraphyses.

In *Urnula* the hymenium is covered by a black membrane which ruptures before the ascospores are discharged. Rupture apparently results from marginal expansion of the disc. Early stages were described and illustrated by Davidson (1950). Davidson said the following of the primordia: "They were dark gray to black, with a white powdery outer surface, about one inch long, cylindrical, rounded at the tip, and occasionally slightly enlarged at the tip end. They were

about the diameter of a pencil. On sectioning they were found to be hollow above and with an immature hymenial layer on the inside. . . ." Later he explains the opening process. "Several of the immature sporophores had enlarged at the tip and started to split open in a stellate manner. No mature asci were present. . . ."

There are other implications of cleistohymenial development in the Sarcosomataceae. The crenate or stellate margins described by Paden and Tylutki (1968) in *Neourrnula* are suggestive of cleistohymenial development and my observations on *Plectania melaena* (Sow. ex Fr.) Fuckel indicates that this species may also be cleistohymenial.

Though these observations are incomplete, they indicate that the mode of apothecial development may be significant at the familial level in the Sarcoscyphineae.

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