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DEVELOPMENT AND MATURATION OF THE PINK FUNGUS (*Upasia salmonicolor*) STAGES IN JAVA

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INTISARI

Pembentukan stadium-stadium jamur upas menunjukkan bahwa di antara lima stadium, stadium sarang labah-labah adalah stadium yang paling penting, karena dapat membentuk empat stadium lainnya.

I. Stadium sarang labah-labah dibentuk dari perkembangan lebih lanjut perkecambahan basidiospora atau konidium, baik di sisi cabang yang terbuka maupun yang terlindung. II. Stadium bongkol semu; dibentuk dari agregasi miselium stadium sarang labah-labah di permukaan lentisel atau celah pada kulit kayu di sisi cabang yang terlindung secara simfogen. III. Teleomorph dibentuk dengan dua cara: a. Kerak teleomorf dibentuk dari stadium sarang labah-labah melalui pembentukan empat lapisan: lapisan basal, lapisan antara, lapisan subhimenium, dan lapisan himenium; b. Pustul teleomorf dibentuk oleh stadium bongkol semu melalui pembentukan empat lapisan seperti kerak teleomorf. IV. Stadium bongkol, dibentuk dari agregasi miselium stadium sarang labah-labah di sisi atas cabang, secara meristogen majemuk. V. Anamorf, dibentuk dengan dua cara: a. Dari stadium bongkol; b. Dari stadium sarang labah-labah di sisi cabang yang terbuka.

Kata kunci: Jamur upas, perkembangan, stadium sarang labah-labah

ABSTRACT

The development of the pink fungus stages showed that among the five stages, cobweb stage is the most important, since this stage may form the other four stages.

I. Cobweb stage, develops following the germination of either basidiospores or conidia both on exposed and shaded side of branches. II. Pseudonodular stage, develops from symphogenous aggregation of cobweb stage mycelia on the surface of lenticel or cracks on shaded bark. III. Teleomorph, develops in two ways: a. Teleomorph incrustation develops from cobweb stage mycelia through four layers: basal layer, intermediate layer, subhymenial layer, and hymenial layer; b. Teleomorph pustule, develops from pseudonodular stage, through four layers, mirror to teleomorph incrustation. IV. Nodular stage, develops from meristogenous aggregation of cobweb stage mycelia on exposed bark. V. Anamorph, develops in two ways: a. From nodular stage; b. From cobweb stage mycelia on exposed bark.

Key words: pink fungus, development, cobweb stage.

INTRODUCTION

This paper reports the continuation study of pink fungus in Java which has been published in Indon. J. Plant Prot. Vol. I(1):19-27, with the topic: Various stages of pink fungus (*Upasia salmonicolor*) in Java, by Tjokrosoedarmo, 1995.

Tjokrosoedarmo (1995) recognized five developmental stages of pink fungus in Java, which were numbered for convenience: I. Cobweb stage; II. Pseudonodular stage; III. Teleomorph; IV. Nodular stage; and V. Anamorph, which have been discussed the occurrence and both macroscopic and microscopic morphology of those stages. This paper will discuss the development and maturation of those five stages completely.

MATERIALS AND METHODS

Materials studied were specimens of pink fungus on three species of living host plants in Java, Indonesia, on which the pink fungus produces five developmental stages. They were *Cinchona ledgeriana* (Howard) Moens (cinchona); *Coffea arabica* L. (coffee); and *Pyrus malus* (apple).

The specimens of the five stages were fixed directly in the field in FAA II (Formalin alcohol acetic acid II). In laboratory, the fixed specimens were studied microscopically by sectioning the specimens. Freehand sections were prepared and mounted sections in cotton blue lactophenol. Good slide preparations were drawn using a camera lucida, and photographed.

RESULTS AND DISCUSSION

On those three species of host plants were found five developmental stages of pink fungus: I. **Cobweb stage**; II. **Pseudonodular stage**; III. **Teleomorph**; IV. **Nodular stage**; and V. **Anamorph**. By studying accuratelly the microscopic morphology of each stage, it can be det⁻mined the development and maturation of those stages.

I. COBWEB STAGE

This stage develops following the germination of either basidiospores or conidia (Fig. 1). The germ tubes develop into cobweb stage mycelia both on the shaded and exposed side of branches. The mycelia spreads over the surface of the bark extensively, and eventually give rise to the other four stages, but hyphae of cobweb stage also penetrate into the living host tissue through lenticels or cracks.

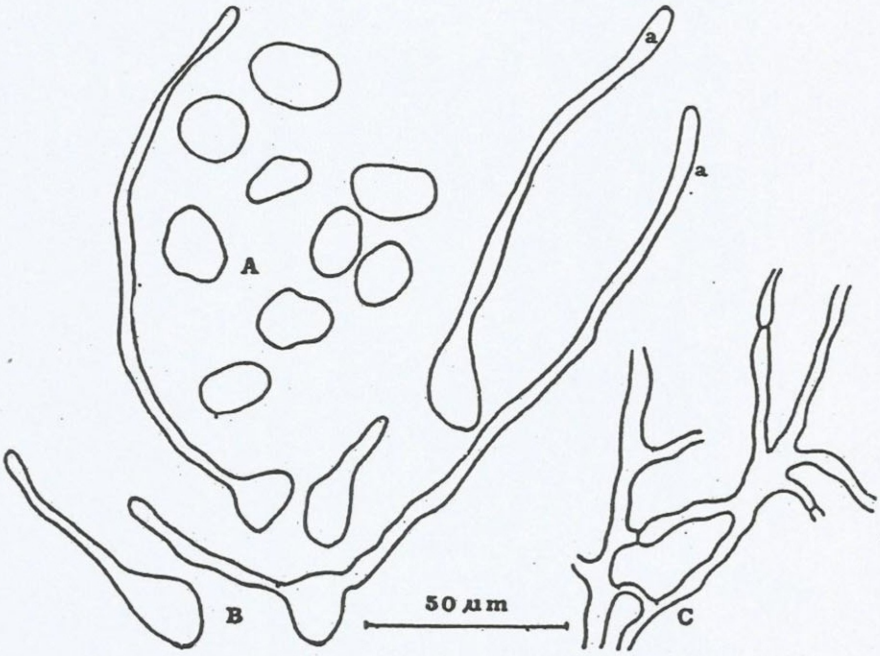

Figure 1. The development of cobweb stage following the germination of conidia. A. Conidia; B. Germinating conidia producing germ tubes (a). C. The development of cobweb stage mycelia from germ tube.

The development of cobweb stage mycelia on shady side of branches differs from the mycelia on the exposed side.

a. Mycelia growing in shade may enter lenticels or cracks of the bark and aggregate within them *symphogenously*. These aggregations later develop into pustules of the **pseudonodular stage** (II), which eventually mature to become **'teleomorph pustules'** (III). At the same time, other areas of shaded mycelia may produce more extensive **'teleomorph incrustation'** (III).

b. Mycelia exposed to both sunshine and rain water during the rainy season, aggregate in a *compound meristogenous manner*. These mycelial aggregations later develop into white **nodular stage pustules** (IV), which finally develop into **sporodochial anamorph** (V). Mycelia on exposed bark may also develop directly into the **anamorph** (V) without passing the nodular stage.

II. PSEUDONODULAR STAGE

This stage is formed on the surface of lenticel or cracks on shaded bark by ***symphogenous aggregation of cobweb stage mycelia***, and finally develops into **the teleomorph pustules** (III). When cobweb stage mycelia in lenticels or cracks penetrate into host tissue, the mycelia on the surface of lenticels develop directly into the teleomorph, and no pseudonodular pustules are formed.

III. TELEOMORPH

The teleomorph occurs in two morphological variants: 1. The form described as ***pink incrustation (teleomorph incrustation)*** develops from the cobweb stage mycelia; 2. The form described as *pink pustule (teleomorph pustule)*, develops from pseudonodular stage (pseudonodular pustules).

Both variants of teleomorph composed of four layers: a. **Basal layer**; b. **Intermediate layer**, c. **Subhymenial layer**; d. **Hymenial layer**.

1. ***Development of teleomorph incrustation*** (Fig. 2). The mature cobweb stage (I) mycelia produce horizontal and perpendicular branches, and function as the *basal layer* of teleomorph incrustation. Then each perpendicular branch of basal layer produces divergent dichotomous or irregular branches 3-4 times. This layer consisting of loose perpendicular branches is called the *intermediate layer*. The ultimate branches of the intermediate layer continue branching many times with very short branches, the length of which is about the same as the width. So that in such a way levelops a layer composed of closely packed divergent chains of short, irregular or rectangular cells, with the ends of the chains always oriented perpendicular to the basal layer. This layer is called *subhymenial layer (subhymenium)*. Eventually those cell chains stop growing, the tip cells enlarge to develop into young basidia and collectivelly forming a layer composed of young basidia in rows called young *hymenial layer (hymenium)*. In the mature hymenium, karyogamy and meiosis (which were not examined in this study) take place and lead to the production of 2-4 basidiospores per basidium.

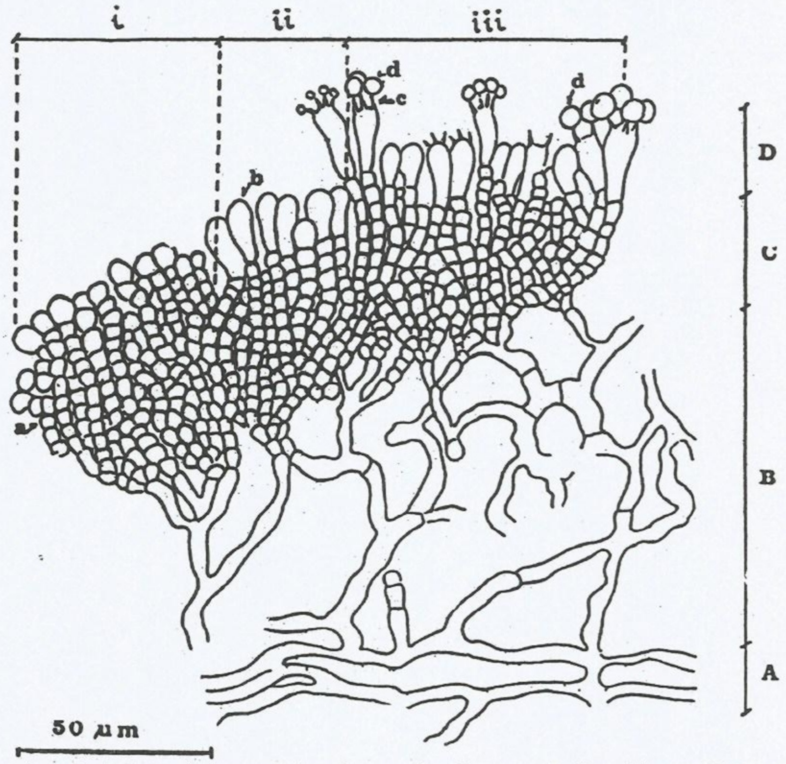

Figure 2. Development of teleomorph incrustation from cobweb stage: A. Basal layer; B. Intermediate layer, C. Subhymenial layer; D. Hymenial layer. i. subhymenial layer consists of sterile cell chains (a); ii. the tip cells enlarge to become basidia (b); iii. mature basidia producing sterigmata (c) and basidiospores (d)

2. ***Development of teleomorph pustules*** (Fig. 3). Teleomorph pustules develops from pseudonodular pustules (II), the tissue cells of which are rounded or irregular in shape (Fig, 3A), as the result of symphogenous aggregation of cobweb stage mycelia. The outermost layer cells of mature pseudonodular pustules (Fig. 3B) functions as the basal layer of the teleomorph pustules. The cells of the basal layer produce perpendicular branches, which further branches like the intermediate layer of teleomorph incrustation, and subsequent development mirror that of the teleomorph incrustation with a subhymenial layer giving rise to a fertile hymenium. So that in such a manner develops a continuous hymenium of teleomorph incrustation to teleomorph pustules (Fig. 3C).

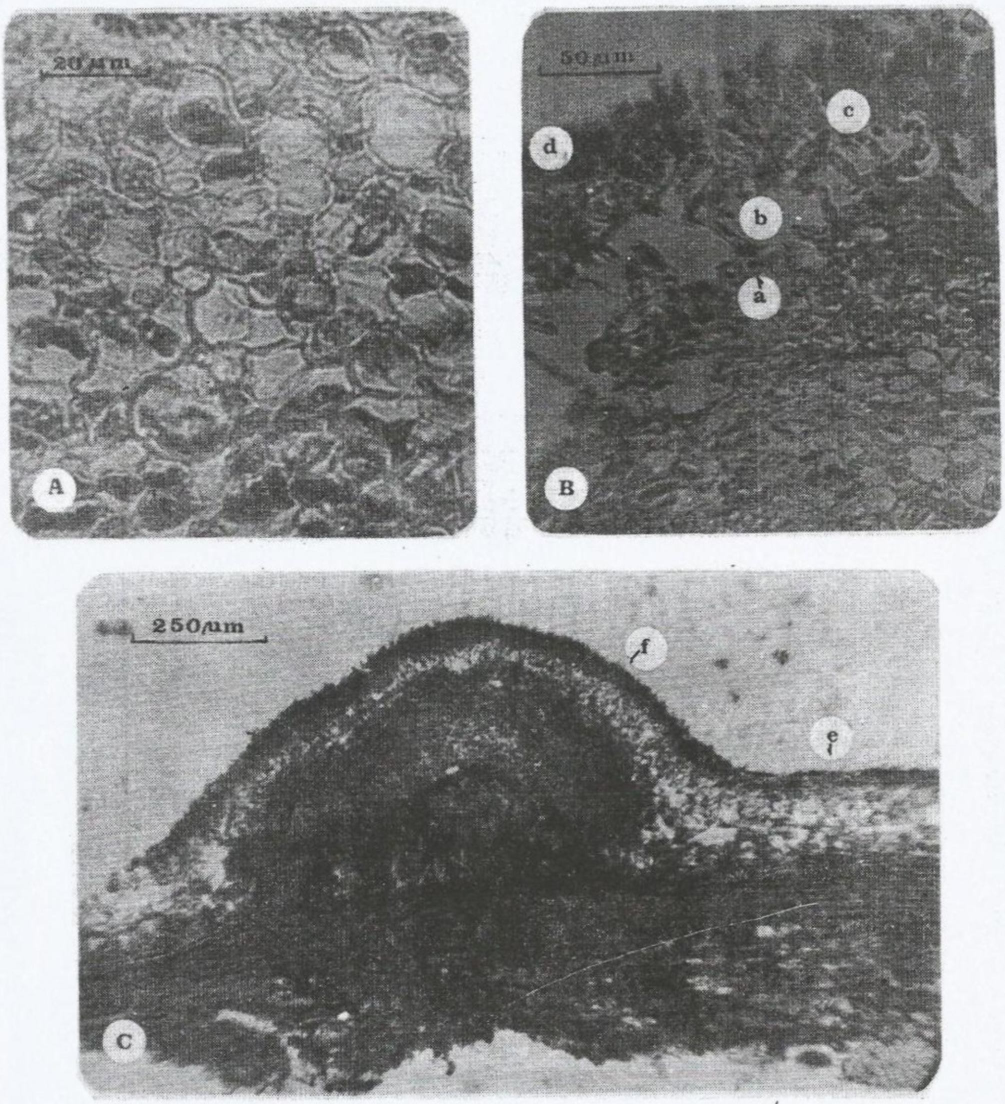

Figure 3. The development of teleomorph pustule from pseudonodular pustule. A. Tissue cells of pseudonodular pustules. B. The outermost layer cells producing teleomorph pustule: a. basal layer cells; b. intermediate layer; c. subhymenial layer; d. hymenial layer. C. The continuous hymenium of teleomorph incrustation (e) to teleomorph pustule (f).

Basidiospores of both variants are liberated by forced actively, and dispersed by wind. The liberated basidiospores germinate on the host bark and the germ tubes develop into cobweb stage (I) on both shaded and exposed bark, and may also on the leaves, which maybe resembles with cobweb fungus or *Spinewebschimmel* (Bally, 1929).

Teleomorph incrustation may also develops on the surface of lenticels or cracks (Fig. 4), when mycelia in the lenticels or cracks penetrate into host tissue, so that no pseudonodular stage produced.

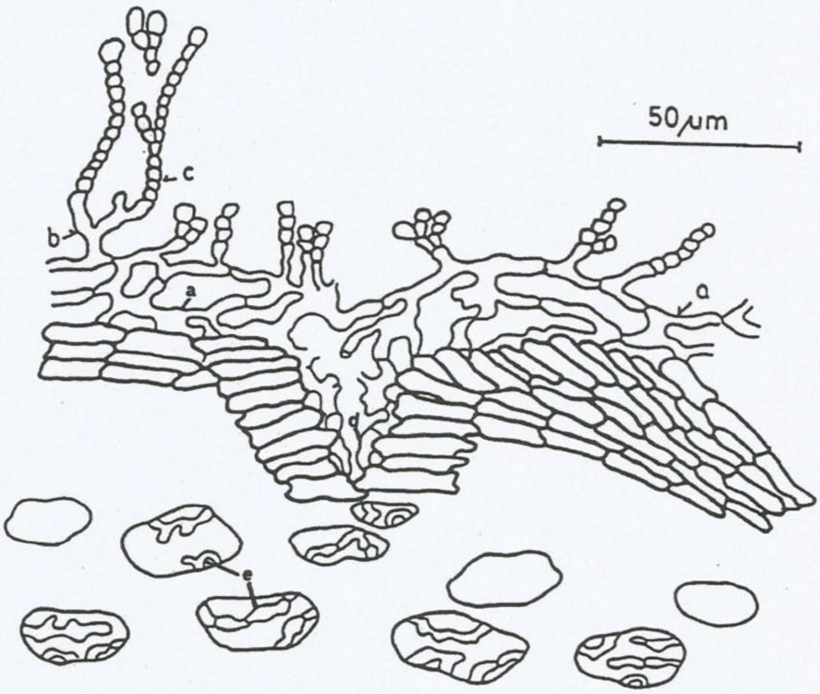

Figure 4. Development of teleomorph incrustation on the surface of lenticel of cinchona. a. basal layer; b. intermediate layer; c. subhymenial layer; d. mycelia in lenticel; e. mycelia in cortex cells

IV. NODULAR STAGE

Field observation suggests that the nodular stage which always occurs on the exposed or upper side of a branch, develops from cobweb stage (I) mycelia. Might be stimulated by sunshine and rain water in the rainy season, the mycelia *aggregate in a compound meristogenous manner*, and develop into white pustules. These are young nodular stage pustules which are covered by a mantle of interwoven hyphae (Fig. 5A). The pustules become larger as long as the environmental stimuli are favorable, and become hemispherical, globose, or irregular by lateral growth (Fig. 5B). At maturity the mantle breaks open and the pustules become orange-red, since the nodular stage develops into the **sporodochial anamorph**.

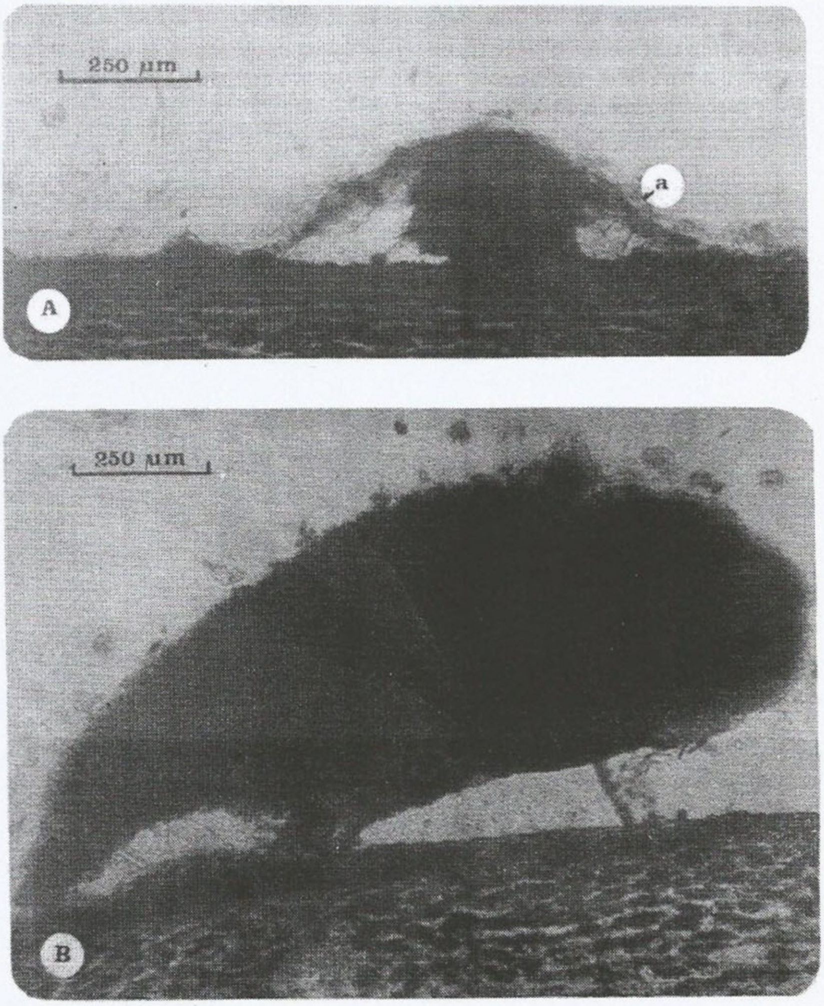

Figure 5. Nodular stage on exposed bark. A. Young nodular stage. a. mantle of interwoven hyphae. B. Mature nodular stage with lateral growth.

V. ANAMORPH

The anamorph, small orange-red sporodochia, develops chiefly from the nodular stage (IV), but may also arise from cobweb stage (I) directly, without passing the nodular stage.

1. ***Development of the anamorph from nodular stage*** (Fig. 6). The mature nodular stage pustules (the tissue cells of which as the result of cell fissions in the process of compound meristogenous aggregation of cobweb stage mycelia) become the stromata of the anamorph. The surface cells of the stroma produce a layer of conidiogenous cells, which produce a layer consisting of basipetal chains of holothallic conidia which are tightly packed. Thus in such a manner the nodular stage develops into sporodochial anamorph.

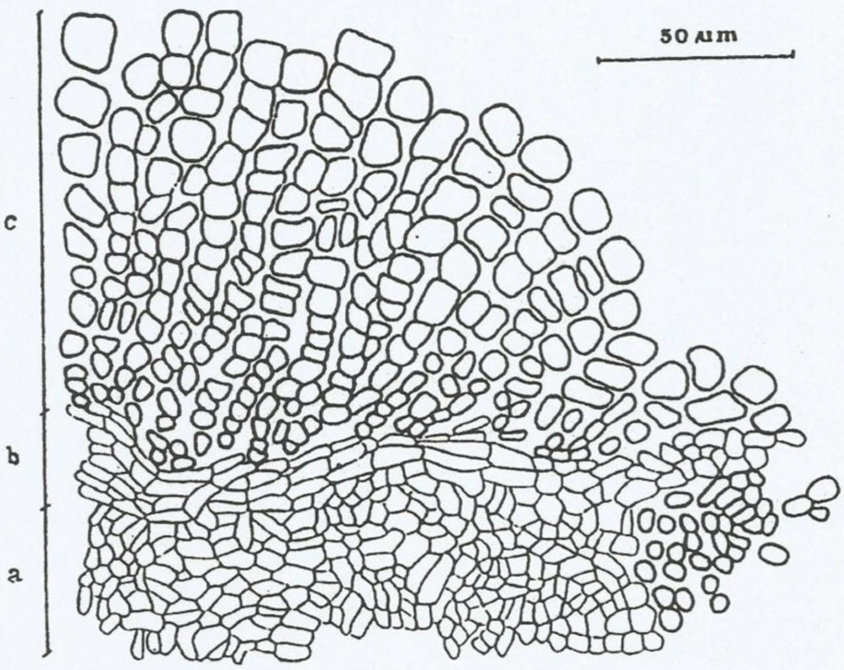

Figure 6. Development of sporodochial anamorph from nodular stage. a. stroma; b. conidiogenous cells; c. basipetal chains of holothallic conidia.

2. ***Development of the anamorph from cobweb stage***. Sporodochial anamorph on *Coffee* species, sometimes develops from cobweb stage mycelia directly, without passing the nodular stage, and may occur on the surface of the bark, but may also above the bark, which connected with the bark by a thick layer of mycelia.

a. ***The sporodochial anamorph which occurs on the surface of the bark*** (Fig. 7A), develops after the hyphae in the host cortex cells develop into conidia. This case happens since epidermis of Coffee bark is so thin, that sunshine and rain water may affect the hyphae in the cortex cells, so that those hyphae develop into conidia.

Then the hyphae on the surface of the bark, affected by the same environmental factors, develop into one cell layer stroma, which then produces one cell layer conidiogenous cells, each cell of which produces basipetal chain/chains of holothallic conidia. The conidial chains are tightly packed, mirror that of sporodochial anamorph which develops from nodular stage.

Brooks & Sharples (1914) stated that in the formation of anamorph pustules, the mycelia aggregate beneath the outermost layer cells of the branch forming a kind of stromata, which subsequently ruptured the host tissue. The whole of the stromatic mass become converted into spores by separation of the cells.

Those deep-seated stromata which rupture the host tissue in Brooks & Sharples' opinion, appear to be the conidia in host cortex cells in this study, which are formed precede the sporodochial anamorph formation on the surface of the bark, and the conidia in the host cells do not rupture the host tissue.

b. ***The sporodochial anamorph which occurs above the bark*** (Fig. 7B), develops from a thick layer of cobweb stage mycelia, which eventually connect the sporodochial anamorph with the bark. The outermost layer of those mycelial layer develop into one cell layer stroma, which produces one cell layer conidiogenous cells, and subsequent development mirror that of sporodochial anamorph on the surface of the bark.

This sporodochial anamorph above the bark (Fig. 7B) also proves that deep seated stromata which rupture the host tissue as Brooks & Sharples' opinion, are not produced.

Conidia of both anamorph development, appear to be mutually adherent, so are presumably dispersed by water or arthropod vectors, not by wind. After liberation, conidia become more rounded, but are still variable in shape and size. The liberated conidia germinate on the host bark in the same manner as basidiospores, and produce cobweb stage (I) in both exposed and shady side of branches (Fig. 1).

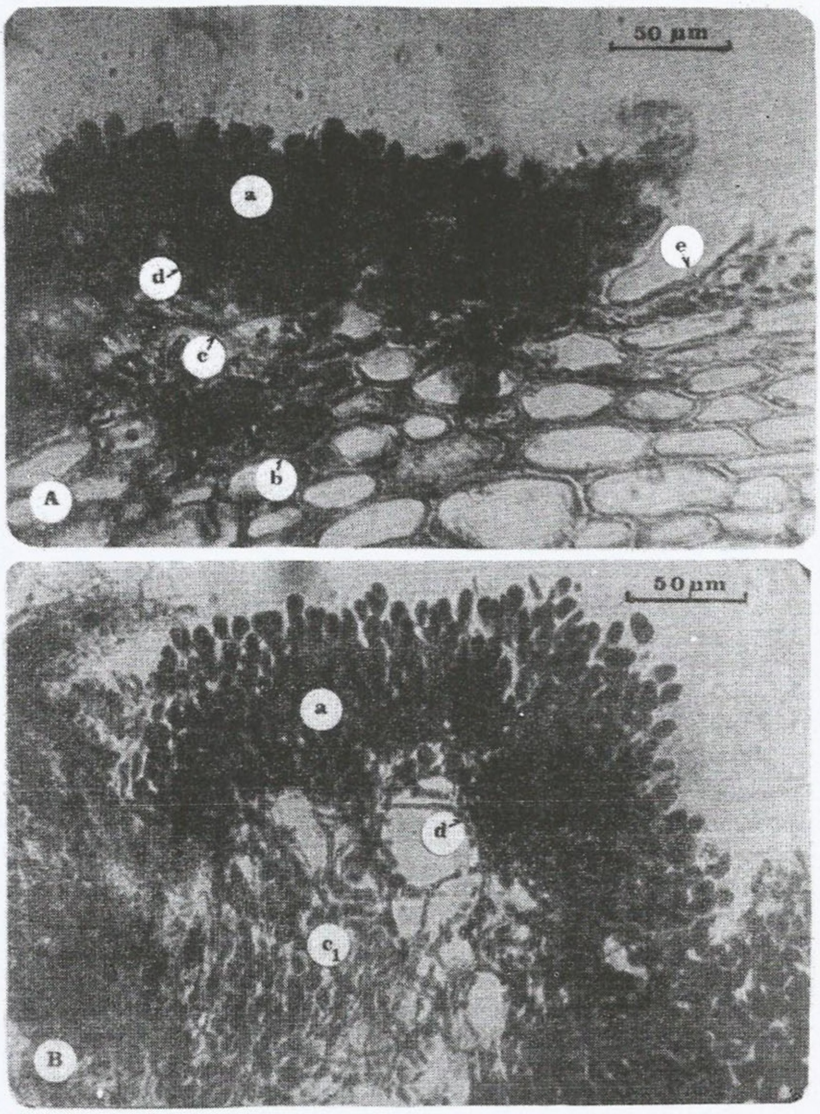

Figure 7. Sporodochial anamorph on coffee bark develops from cobweb stage: A. Sporodochial anamorph on the bark surface; B. Sporodochial anamorph above the bark surface. a. mass of conidial chains; b. mass of conidia in the host cells; c. cobweb stage mycelia producing one cell layer stroma (d); c_1=c and also connect the sporodochial anamorph with the bark; e. epidermis of coffee bark.

The result of this study showed that development and maturation of pink fungus stages are as follows;

I. Cobweb stage develops following the germination of basidiospores or conidia; II. Pseudonodular stage develops from symphogenous aggregation of cobweb stage mycelia on shaded bark; III. Teleomorph incrustation develops from cobweb stage mycelia, and teleomorph pustule from pseudonodular stage pustule; IV. Nodular stage develops from compound meristogenous aggregation of cobweb stage mycelia on exposed bark; V. Anamorph develops from nodular stage or from cobweb stage.

It is concluded that cobweb stage is the most important among the five stages of pink fungus, since cobweb stage may form the other four stages.

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