Basidiospore Development and Fine Structure of *Entoloma squamiferrum*

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비늘외대버섯의 담자포자 발생과 미세구조

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Abstract

Basidia of *Entoloma squamiferrum* are developed from hymenium layer of crator-shaped parabasidium. Apex of basidium is flat or depressed in the center. Although four sterigmata are developed, only two sterigmata are symmetrically swollen to two spores in certain basidia. It means that two sterigmata among four sterigmata are infertile. A spore is formed by inflation of the apex of the sterigma. The apex of the sterigma is swollen into a paillaform and then turned into a penisform. It is swollen from a clubform into a globeform. Six spots of the surfaces of globose spore are depressed with hilum axes. Finally the spore is cuboid, and then it is released from hilum.

KEYWORDS : basidiospore, parabasidium, *Entoloma squamiferrum*, basidium, sterigma, cuboid.

The fine structure and the basidial development of higher fungi have been studied by many workers (Clemencon, 1969. Corner, 1948. Lerbs, 1971. Talbot, 1973. Thielk, 1976). The developmental structure and the mature basidiospore have been studied with electronic microscope(Clemencon, 1970. Kühner, 1973. McLaughlin, 1973, 1977. Nakai, 1975. Nakai and Uhiyama, 1974, 1978. Pegler and Young, 1971, Perreau-Bertrand, 1967. Wells, 1965).

Spores development of the genus *Russula* have been studied in several other hymenomycetes taxa hypothesis, which attempt to describe general aspects of the basidiospore structure and the development in the genus *Russula*(Burge, 1979).

These studies were on meiosis in basidia and structure of spores. They didn't contain the genus *Entoloma*. The spores of the genus *Entoloma* are multi-angular and they have five kinds of form, which are isodiametrical, heterodiametrical, nodulose, cuboid and cruciform.

A hypothesis was presented on the process of the spore formation in the *Rhodophyllus*(synonyum of the *Entoloma* : Romagnesi, 1941, 1978).

This study investigates in detail the development and structure of the spore in *E. squamiferrum* with scanning electronic microscope and reevaluates the existing hypothesis of spore development in the *Entoloma*.

Materials and Methods

Carpophores of *Entoloma squamiferrm* were collected at Mt.Naejang National Park on 20, July, 1990.

The fragments of lamellae of fresh carpophores were fixed with 2.5% paraformaldehyde–glutraldehyde(pH. 7.2). These were washed with phosphate buffer(pH. 7.2). They were fixed with 2% osmium tetroxide(OsO_4) again and were washed with phosphate buffer(pH. 7.2). These were dehydrated with acetone series and dried for 24 hours naturally. These materials were 150Å of Au–Coating with Ion Coater(Eiko IB–3) and scanning electronic microscope(ISI–SS 40) was used for observation.

Results and Discussions

The basidia(Fig. 1–A) of *E. squamiferrum* are developed irregularly from crator–shaped parabasidia(Fig. 1–B). Their apexes are two kinds, one of which is roughly flat(Fig. 3.–B) and the other is smoothly(Fig. 2–B) or roughly(Fig.8–B) depressed in the center. The basidiospore initial is formed by inflation of the apex of the sterigma(Webster, 1990).

A sterigma is directly developed from crator–shaped basidium of *E. violaceobrunneum*(Cho, 1992). Authors guessed that the crator–shape of this species is parabasidium, which has preservational function when basidium is borne from the base of the crator. The parabasidium of crator is circle–squared, which is 4.3–5.7×5.7–7.1㎛. The depth of the parabasidium varies(Fig. 1–B).

The spore formation in basidia flattened on the apex : The sterigma is developed from flat of the basidium and the surface is rough(Fig. 3–B). The sterigma of initial development is papillate(Fig. 2–A, 3–A) which is 0.7–0.8㎛ in diameter(Fig. 3–A). The basidium is 4.0–4.8㎛ in dia.(Fig. 3). The papillaform of sterigma is swollen and elongated to a subclub, which is 1.4–1.8㎛ in dia.(Fig. 4) and basidia are 6.0–8.0㎛ in dia.(Fig. 4). Then the subclub is more swollen in elongation than in volume, so it is clubform(Fig. 5,6) which is 1.3–1.5×1.6–2.0㎛(Fig. 5) and 1.8–1.9×2.9–3.0㎛(Fig. 6). Also hilum is formed(Fig. 5–B, 6–C). This is the coincidence of the hilum formation in sporal development initial of the *Russula*(Burge, 1979).

The bases of the sterigmata are bulbose(Fig. 5–C). The apex of basidium is irregularly swolen(Fig. 5–D) to form the range(Fig. 6–B, 7–B). The hilum is constricted(Fig. 6–C). The clavate spores are more swollen in volume than in elongation, then they turn subglobose(Fig. 7), which is 1.8–1.9×2.0–2.3㎛.

The spore formation in basidia depressed in the center : The surface of the basidia are two kinds which are smooth(Fig. 2–B) and rough(Fig. 8–B). The acutic sterigma(Fig. 8–A) is developed from the apex of the basidium(Fig. 8–B). At first, apex of basidium is uneven(Fig. 8–B) but it is gradually and more deeply depressed to the center(Fig. 9,10). The sides of basidium are uneven(fig. 8–C, 9–B, 10–B) or smooth(Fig. 2). The acutic sterigmata are 0.5–0.8×0.8–1.0㎛(Fig. 2) or 0.6–0.7㎛ in dia.(Fig. 8). Then the acutic sterigma is swollen to papillaform(fig. 9–A) which is 0.5–0.6×1.0–1.2㎛.(Fig. 9). A papillaform is swollen to a penisform(Fig. 10–A), which is 0.4–0.7×0.8–1.1㎛(Fig.10). The apex of basidium is gradually and sucessively depressed(Fig. 11－A). A penisform is swollen to a subclubform(Fig.11) and then a clubform(Fig. 12,13) through the elongation rather than the volume. The subclubform is 1.3×1.5㎛(Fig. 11) and the clubform is 2.0－2.5×2.4－3.4㎛(Fig. 12).

When four sterigmata are developed, four spores are formed. But this observation shows that two spores are symmetrically formed in spite of four sterigmata(Fig. 13). It means that two sterigmata of the others are symmetrically infertile(Fig. 13－B). It is not known whether this cause is abnormal meiosis in basidia or lack in ability of sterigmata to get swollen. The clavate spore is 2.0－2.5×3.0－3.8㎛(Fig. 13) and infertile sterigma is 0.4㎛ in dia(Fig. 13－B). The apex of basidia is more swollen to form ranges and is irregularly depressed(Fig. 13－D). The margin of basidium is irregular(Fig. 8,9,10,11,12,13) and is 0.4㎛ wide(Fig. 12－B). The clavate spore is swollen to subglobose spore through the volume rather than thd elongation(Fig. 15－A).

Romagnesi(1941, 1978) proposed that two prototypes of spore have different origins. Firstly when the spore sterigma is oval, it becomes a cube with quadrangles. Secondly when the spores of sterigma is clavate, it becomes a triangle.

But this study on this species shows that the surface of the globeform changes from subquadrate(Fig. 15－A) to quadrate(Fig. 14－A) with hilum axes. Then quadrate is gradually and irregularly depressed(Fig. 14－A). When the depression of the surface of quadrate is over, it is cuboid spore(Fig. 14－A). When the depression of the surface of quadrate is over, it is cuboid spore(Fig. 16－A). Then the spore is released from the hilum.

According to observation in spore formation of this species, cuboid spores are formed by the following process.

The sterigmata are developed from basidia which are borne from crator－shaped parabasidium. Only two spores are symmetrically formed in spite of four sterigmata in certain basidia. Two of the other two are infertile sterigmata. The apex of sterigma is swollen to a papillaform and then to a penisform. Again it is swollen to from a clubform to a globeform. Finally when six spots of the surfaces of the globeform are depressed, it is cuboid spore which is released from hilum.

摘　　要

비늘외대버섯의 담자기(basidium)는 분화구 모양의 의사담자기(parabasidium)로부터 발생한다. 담자기의 꼭대기는 평평한 것과 가운데가 함입된 것이 있었다.

어떤 담자기는 4개의 병자(sterigma)가 발생하여도 그중 2개는 대칭적으로 포자를 형성하고 다른 2개는 불임의 병자가 되는 것도 있다.

담자포자는 병자의 끝이 부풀어서 형성되는데 비늘외대버섯은 처음에 병자의 꼭대기는 부풀어서 젖꼭지(papilla) 모양이 되고 이것은 성기(penis) 모양으로 부푼다. 다시 이것은 방망이(club) 모양이 되었다가 구형(globe)의 모양이 된다. 이 구형의 표면의 6곳에서 방출축(hilum axes)을 중심으로 함입이 일어나서 주사위(cuboid)모양의 포자가 되면 포자는 방출점에서 떨어진다.

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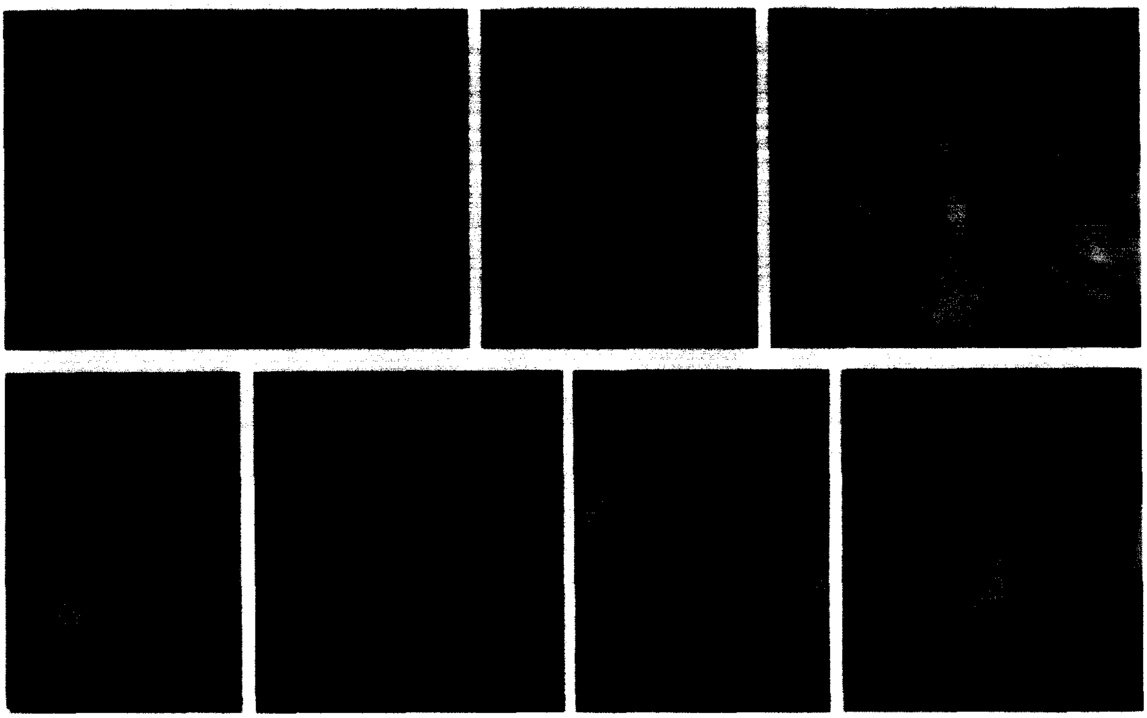

Fig. 1－2 : Electron micrographs of basidia developed from parabasidia
1－A, basidia, 1－B, parabasidia
2－A, papillate sterigma, 2－B, depression of apex of basidium
Fig. 3－7 : Electron micrographs of spore formation in basidia flattened on the apex
3－A, papillate sterigma, 3－B, roughly flat of apex of basidium
4－A, subclavate spores
5－A, clavate spore, 5－B, hilum, 5－C, base of sterigma
5－D, swollen range of apex of the basidium
6－A, clavate spore, 6－B, swollen range of the apex of the basidium
6－C, construction of the hilum
7－A, subglobose spore, 7－B, swollen range of the apex of the basidium

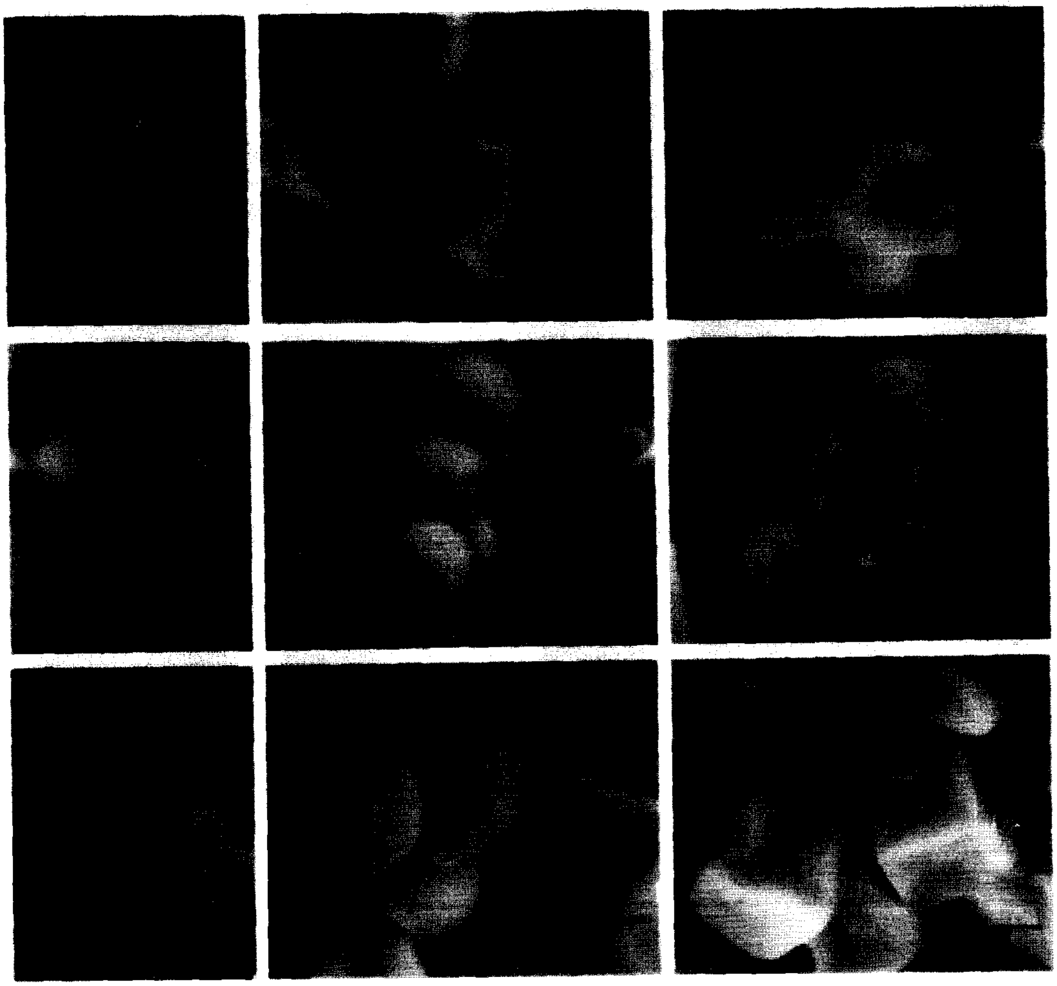

Fig. 8−13 : Electron *micrographs of spore formation in basidia depressed in the center*

8−A, acutic sterigma, 8−B, rough flat of the apex of the basidium

8−C, margin of the basidium

9−A, papillate sterigma, 9−B, margin of basidium

10−A, penisform sterigma, 10−B, margin of basidium

11−A, depression of the apex of the basidium, 11−B, subclubform

12−A, clavate spore, 12−B, margin of the basidium

13−A, subglobose spore, 13−B, infertile sterigma.

13−C, hilum, 13−D, depression of the apex of the basidium

Fig. 14−16 : Electron micrographs of spore formed from globose spore to cuboid spore

14−A, depression of the surfaces of the globose spore and quadrate

15−A, subquadrate side of spore

16−A, cuboid spore