Male Sterility Caused by Cooling Treatment at the Young Microspore Stage in Rice Plants

XIV. Floating tapetal materials in the locular cavity.

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The earlier papers^{1,2,3)} of this series reported the ultrastructures of tapetal hypertrophy induced by cooling treatment around the young microspore stage. This paper describes electron microscopical observations on the tapetal materials floating in the locular cavity.

MATERIALS AND METHODS

Materials and methods are the same as those described in an earlier paper³⁾.

RESULTS

Fig. 1 shows dispersed tapetal materials in the locular cavity. Nuclei, endoplasmic reticula, plastids, mitochondria and broken cell membranes with orbicules are floating around microspores. These materials originated from the bursting of balloon-flame type hypertrophy. Fig. 2 is dispersed tapetal materials at the beginning of degeneration. The nuclei are ovoid.

Fig. 3 shows floating tapetal materials which have an envelope membrane. This envelope membrane is not accompanied by orbicules, thus it is considered to have originated from endoplasmic reticulum. Other clusters of tapetal materials are seen in the locular cavity.

Fig. 4 shows the bursting of tapetum. Some contents of the tapetum spouted out through a pore which was made by the breaking of cell membrane. Cell organelles are much sparse at some parts of original tapetum.

Fig. 5 is a cluster of floating tapetal materials between a microspore and a tapetum. Endoplasmic reticulum is alveolate like microsomes.

Figs. 6 and 7 show two examples of a bursted tapetum after hill type dilatation. In fig. 7, the contents of the dilated cell dispersed out into the locular cavity, and only a small amount of remnants are observable.

Figs. 8 and 9 show aggregates of tapetal materials floating in the locular cavity. These aggregated materials are, in many cases, degraded balloon type cells. Autolysis is in progress and lipid globules are accumulating.

DISCUSSION

Materials of tapetal origin are frequently observed floating in locular cavities of anthers which were cooled around the young microspore stage. These materials appear in dispersed state around microspores, or in a cluster, or in an aggregate.

The dispersed materials mainly result from the bursting of swelling tapetal hypertrophy, including hill, flame and balloon types. This bursting is due to an overly-high turgor pressure of the cell. The proliferation of the cytoplasm, especially the cell membrane, can not follow the increase in the turgor pressure. The bursting occurs even in a small scale dilatation (fig. 4), and results in dispersed materials. The degeneration of cell membrane of dilated tapetum can also be a cause of dispersed materials.

The cluster of tapetal materials comes from the bursting (fig. 4), or from the degeneration of cell membrane of dilated tapetum.

The aggregated tapetal materials mainly result from contracted balloon type hypertrophy. Dispersed and clustered materials in the cavity can result in aggregates.

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Fig. 1 Dispersed tapetal materials which originated from balloon-flame type hypertrophy. MS: microspore; T: tapetum; N: nucleus; ER: endoplasmic reticulum; P: plastid; M: mitochondrion; O: orbicule. An arrow shows a broken end of cell membrane with orbicules. $\times 4,000$

Fig. 2 Dispersed tapetal materials at the beginning of degeneration. MS: microspore; T: tapetum; N: nucleus; ER: endoplasmic reticulum. $\times 4,000$

Fig. 3 Floating tapetal materials with an envelope membrane (FT). Arrows indicate other clusters of tapetal materials. T: tapetum. $\times 4,000$

Fig. 4 Bursting of tapetum. Arrows indicate ends of broken cell membranes with orbicules. ST: spouted-out tapetal materials; T: original tapetum. $\times 4,000$

Fig. 5 A cluster of floating tapetal materials. T: tapetum; ER: endoplasmic reticulum; P: plastid; V: vacuole. $\times 8,000$

Fig. 6 Bursting tapetum after hill type dilatation. N: nucleus; ER: endoplasmic reticulum; P: plastid; M: mitochondrion; TR: transitory tissue. Arrows indicate the broken sites of cell membranes and walls which separated original tapetal cells. $\times 4,000$

Fig. 7 Bursting tapetum after hill type dilatation. Cell contents dispersed out into the locular cavity and only a small amount of remnants (TM) are seen. Arrows indicate the broken cell walls and membranes of original tapetal cells. TR: transitory tissue. $\times 4,000$

Fig. 8 Aggregates of floating tapetal materials (FT). These materials may have originated from balloon type hypertrophy. BMS: broken microspore. $\times 4,000$

Fig. 9 Aggregates of floating tapetal materials. P: plastid; M: mitochondrion; V: vacuole; L: aggregate of lipid globules. $\times 6,000$

Thus, the floating tapetal materials in the cavity originate from tapetal hypertrophy, including the bursting of tapetum at the beginning of the dilatation. The causes of the occurrence are turgor pressure in the tapetal cells and degeneration of the cell membrane. Therefore, the occurrence and existence of the floating materials is considered to affect cool-induced sterility in the same way, fundamentally, as tapetal hypertrophy³⁾.

SUMMARY

Tapetal materials floating in the locular cavity were observed through electron microscope for anthers cooled at the young microspore stage.

The floating materials appeared in three types: dispersed state, cluster and aggregate. The cause of the occurrence was the bursting or the degeneration of the cell membrane of dilated tapetum.

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LITERATURE CITED

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〔和 文 摘 要〕

イネの小孢子初期冷温処理による雄性不稔

第14報 葯腔中に浮遊するタペート性物質

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小孢子初期ころに冷温処理をおこなったイネの葯を電子顕微鏡観察のために固定、染色した。

この材料で、葯腔中にタペート性の物質が浮遊しているのがしばしば観察された。この浮遊物には分散状、集合状および凝集状の3型がみられた。分散状浮遊物は主として膨潤的タペート肥大(丘、炎、風船状の各型をふくむ)から、凝集状浮遊物は主として収縮的風船状肥大から、そして集合状浮遊物はいくつかの径路から由来していた。これら浮遊物の生因は3型のいずれも肥大タペート細胞の細胞膜の破裂あるいは退化によるものであり、その冷温不稔にたいする影響もタペート肥大と基本的に同じものであるとみられる。