Process of Fertilization in *Oryza sativa* L. with Relation to Time

In the process of fertilization, the time intervals between gametic fusions are so short that it is very difficult to 'catch' the material at the right stages. Besides, pollen tube contents discharged into the embryo-sac take very deep stain, decreasing visibility. Perfectly median sections are also necessary to obtain the whole complement in one section.

In view of these difficulties our knowledge of the events concerned with fertilization is poor, and there are only a few records of the process in relation to time[1,2]. In crop plants especially, this data is of great importance since breeding experiments can then be carried out with better insight. Studies on fertilization of *Oryza sativa* L. in relation to time have been carried out[3] and a few interesting variations are recorded here.

Anthesis in rice is normally at its peak from 10.30 to 11.30 h. Prior to anthesis the lodicules swell forcing the flowering glumes apart and the anther filaments grow to almost twice their length. The anther lobes come out and brush against the glumes, resulting in the shedding of pollen grains which are readily caught by the feathery stigma. The lodicules lose their turgidity and shrivel 2 to 3 h after anthesis so that the flowering glumes close, shutting the pistil from the outer environment. A large number of pollen grains are shed on the stigma and all of them start germinating almost immediately. The pollen tube makes its way in between the stigmatic papillae into the tissues of the style and enters the embryo-sac through micropyle. The synergids degenerate and disappear, taking no part in the process of fertilization. Prior to the discharge of the pollen tube contents, the polar nuclei which are in the center of the embryo-sac migrate towards the micropylar end and remain pressed to the egg so that male gametes discharged are in close proximity to their mates. With the bursting of the pollen tube into the embryo-sac, the male gamete that comes out first is received by the polars while the other that follows remains near the egg cell. Having received the male gamete, the polars go back to their original central position in the embryo-sac. The male gamete than comes closer to one of the polars, penetrates its nuclear membrane and fuses with it. Almost immediately the remaining polar nucleus also fuses with this 'zygote', giving rise to a primary endosperm nucleus. Similar variations in fusions have been recorded earlier in *Nicotiana*[4], *Waltheria*[5], *Melochia*[6] and *Bowlesia*[7]. This deviation, however, seems to be without any basic significance[8]. The primary endosperm nucleus, without undergoing any period of rest, divides and redivides to give rise to nuclear endosperm.

The second male gamete penetrates the egg cell wall and comes to lie near its nucleus. Slowly and steadily it makes its way into the nucleus of the egg cell giving rise to a zygote, which undergoes a period of rest for about 1 h and divides by a transverse wall giving a two-celled pro-embryo.

The rate of growth of pollen tube and the process of double fertilization are affected to an appreciable extent by environmental conditions, especially temperature and humidity. This explains why most of the rice varieties when grown out-of-season show high sterility.

Germination of pollen grains starts immediately after anthesis and within 5 min profuse growth of pollen tubes is seen all over the stigma. Pollen tubes appear near the micropyle about 30 to 45 min after anthesis, while male gametes are seen discharged into the embryo-sac after 1.5 h. The development towards the formation of embryo and endosperm is tabulated giving only important steps in the process.

Fertilization in *Oryza sativa* L.[a]

Time elapsed after anthesis (h)	Development towards formation of endosperm	Development towards formation of embryo
2	Male gamete in association with 1 of the polars	Other male gamete in contact with egg cell
2.5	Polars go back to center of embryo-sac with 1 of the male gamete	Same as at 2 h
3.5	Male gamete very close to 1 of the polars	Male gamete inside the egg cell
4.5	Fusion of polars with the male gamete	Male gamete advancing towards egg cell
5	First division of the primary endosperm nucleus	Male gamete very close to egg nucleus
5.5	4 to 6 endosperm nuclei	Male gamete in contact with egg nucleus
7	Many free endosperm nuclei	Same as at 5.5 h in 20% ovules, in others it is close to nucleolus
8		Formation of zygote
9.5		Two-celled pro-embryo

[a] The process of fertilization is studied from pollination to the first division of zygote and readings are taken in 10 ovules at half-hour intervals.

Résumé. Le processus de la fertilisation chez l'*Oryza sativa* L. a été étudié de l'anthesis à la première division de zygote par rapport au temps. Deux variations intéressantes ont été obtenues: le mouvement en avant et de retour des polaires vers l'extrémité micropylaire pour recevoir le gamete mâle, et la séquence non conventionnelle des fusions des polaires avec le gamete mâle.

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