Proceedings of the Iowa Academy of Science

Volume 54 | Annual Issue Article 13

1947

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In recent experiments involving the germination of the pollen grains of *Vinca rosea,* it was observed that relatively poor germination occurred in isolated grains and among those grains aggregated in small groups (Beams and King, 1944). These preliminary observations seemed to warrant a further study of this problem. Accordingly, experiments were designed to determine some of the effects of population density on the percentage germination of these cells.

Pollen grains from a single anther of *Vinca rosea* grown in the laboratory during the months of March or April were used in each set of experiments. When taken from the anther, the pollen grains are held together by a yellowish sticky substance. The grains were placed on a medium composed of 2% agar and 10% sucrose in petri dishes. Upon being placed on the culture medium, the sticky substance dissolves freeing the grains which immediately imbibe water. Microscopic examination of the grains at this stage discloses three triangularly placed pores in the exine from only one of which usually a tube emerges at germination. After standing from 2 to 4 hours in covered petri dishes at 25°C. in the dark, the grains were examined for the presence of pollen tubes, the criterion used here to determine germination.

When the pollen grains are sown on an agar plate, some fall singly, some are in groups of two, three, etc. Germination was tabulated according to the number of pollen grains in a group. The combined results of three such experiments are listed in Table I. It will be observed that only 1.3% of the singly isolated grains germinated and that there is a gradually increasing percentage of germination, as the group becomes larger, up to about eight or ten grains in the group. Here the germination becomes constant at about 70%.

Our studies do not permit us to enter far into a discussion of the probable explanation of these results. However, it seems reasonable to assume that some readily diffusible growth promoting substance or substances are given off by the pollen grain. When only a few grains are in a group, the concentration of these is below the threshold of germination. If this be true, a greater concentration of the diffusible substance responsible for germination would be present when the grains are in larger groups; which is responsible for a higher percentage of germination in such larger groups.

This view is supported by the work of Beck and Joly (1941), that better germination and longer pollen tubes occurred in thickly populated cultures (40 to 100 grains) than in sparsely populated ones (4 to 8 grains). They believe that the relationship between the number of grains seeded and the power of germination is directly associated with the concentration of auxin present. The auxin is

thought to be associated with the sticky oily material surrounding the grains. However, Brink (1924), was unable to substantiate this view. He concludes that the substance promoting increased growth in pollen tubes is apparently a product of the metabolism of the tubes themselves which is utilized more completely when the tubes are massed.

The addition of certain plant materials to the culture medium such as crushed stigma, yeast or raw potato has been found to increase tube growth, but the mechanism of this effect is not clearly understood (Brink, 1924).

Haberlandt, according to Harrison (1928), has observed that increase in size occurs in isolated plant cells but division does not occur. In addition, he reports a direct relationship between the size of the piece of plant tissue transplanted, or the number of cells within it, and the number of cell divisions which take place. He concludes from these experiments that the factor responsible for inciting cell division is in the nature of a "wound hormone." Harrison, too, states that "It is a very interesting and at present inexplicable fact that single somatic cells isolated in culture media do not poliferate."

In many other animal cells, also, it has been observed that the population density may have a marked effect upon growth (Allee, 1931). For example, it has been demonstrated that the eggs of Arbacia cleave more slowly when placed singly than they do when placed in small groups (Allee and Evans, 1937). A similar condition has been recently described for the frog egg (Merwin, 1945). This acceleration takes place even though every effort is made to control such environmental conditions as temperature, carbon dioxide and oxygen concentrations. The percentage of fertility of scattered frog eggs is also lower than that of the bunched ones. In this connection Merwin has ably stated that the factor or factors causing acceleration of cleavage in small bunches of frog eggs over that of an isolated egg is unknown.

Finally, it may be said that such group-initiated modifications in germination, growth, etc., undoubtedly exist, but that no single explanation is probably valid for the phenomena in different groups of animals and plants.

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Table I

Percentage germination of pollen grains in groups of different size.

Number of grains in group	Total number of grains	Germinated number	Germinated %
1	467	6	1.3
2	426	57	13.4
3	462	104	22.6
4	320	123	38.5
5	375	188	50.0
6	240	136	56.8
7	245	145	59.2
8	192	132	68.8
9	207	122	59.0
10	160	117	73.6
11-19 incl.	707	548	72.4
	3801	1678	44.2

Literature Cited

Allee, W. C. 1931. Animal aggregations. University of Chicago Press, Chicago.

Allee, W. C. and G. Evans. 1937. Further studies on the effect of numbers on the rate of cleavage in eggs of Arbacia. J. Cell. and Comp. Physiol. 10: 15-28.

Beams, H. W. and R. L. King. 1944. The "negative group effect" in the pollen grains of *Vinca rosea*. J. Cell. and Comp. Physiol. 23: 39-45.

Beck, W. A. and R. A. Joly. 1941. Some growth phenomena in cultured pollen tubes. Trans. Am. Micr. Soc. 60: 149-162.

Brink, R. A. 1924. The physiology of pollen IV. Am. J. Bot. 11: 417-436.

Harrison, R. G. 1928. On the status and significance of tissue culture. Arch. f. exp. Zellforsch. Bd. 6: 24-27.

Merwin, R. 1945. Some group effects on the rate of cleavage and early development of frog eggs (Rana pipiens). Physiol. Zool. 18: 16-34.