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INTUITION, REASON AND FAITH IN SCIENCE¹

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FROM the earliest times scientific ideas even when crudely conceived have been of immeasurable importance, not only for man's material advancement and control over nature, but also in modifying and expanding his philosophic and religious outlook. In the effort to obtain a better understanding of his place in the cosmos, he is compelled to proceed largely by considerations of analogy based upon supposed or actual fact. And so he turns more and more toward the ever-widening vistas suggested by science in its continual discoveries of new truth.

To-day the significance of science as a principal source of revelation is almost universally recognized. Thus recently, on behalf of Pope Pius XI, Cardinal Pacelli spoke before the Pontifical Academy of Sciences concerning the enlightenment that comes from

"the potent streams of the natural and rational sciences and the great river of revealed wisdom."² He said that the former are found "wherever man looks for and finds truth." As for "the great river of revealed wisdom," is it not to be found in all the absolutely sincere utterances of poets, philosophers and prophets, based on the relevant knowledge of their day and made after deepest meditation? It would seem that such utterances are in essence similar to the pronouncements of the scientist. Is not the vague, prophetic conjecture of Pythagoras that nature is mathematical as true as Newton's more precise law of gravitation? From this point of view, the great streams of revelation seem to merge insensibly into one.

Nevertheless, the immediate effect of scientific advances is often very disquieting. The strong opposition long shown to the Darwinian theory of evolution

¹ Address of the president of the American Association for the Advancement of Science, Richmond, Va., December 27, 1938.

² See SCIENCE, 86: 2238, 470-472, November 19, 1937.

VITAMIN B₁ AND THE GERMINATION OF POLLEN

BEGINNING with the work of Von Mohl¹ in 1838, varying degrees of success have attended attempts to cultivate pollen *in vitro*. The culture media in most cases consisted of a mixture of sugar and agar or sugar and gelatine. A very considerable improvement in these culture media was effected by Brink,² who discovered that a water extract of sterile yeast added in small amounts to the sugar media stimulated pollen tube germination.

In recent years it has been found³ that the beneficial effects of yeast extracts on the growth of excised roots *in vitro* was due in part, at least, to the vitamin B₁ content of the yeast extract. This consideration has led the writers to suspect that vitamin B₁ might be the substance in yeast extract that produced the beneficial effects observed by Brink. That this vitamin does actually accelerate germination of pollen is shown in the following experiments.

Pollen from *Carica quercifolia* and from the Orlando, Fairchild and Florida varieties of *Carica papaya* was tested for germination percentage in Van Tiegham cells, using a medium of 4 per cent. sucrose and $\frac{3}{4}$ per cent. agar with and without the addition of crystalline vitamin B₁ (0.1–200 gamma per cc). With the exception of the Orlando variety, an addition of 100 gamma B₁ per cc resulted in a significant increase in the germination percentage over that obtained without B₁ (Table 1). This increase was, however, in most in-

survey of the effectiveness of various concentrations of B₁ on the germination of pollen of the Florida variety showed that a maximum response was attained with 100 gamma per cc. Some acceleration in germination over controls was obtained from 50 gamma, but 0.1, 1 and 10 gamma gave no response. This effect from such high concentrations of B₁ is interesting in view of the fact that the optimum B₁ concentration for root growth has been found to be near 0.002 gamma per cc.³

Vitamin B₁ has been detected by biological assay in leaves, stems, roots, fruits and seed of many plants (Summary in Sherman and Smith.⁴) Also Dutcher⁵ has demonstrated the presence of vitamin B in maize pollen. It may be that germination of pollen taking place without the addition of an external supply of B₁ is caused by naturally occurring vitamin B₁ in the pollen. Further work on the physiology of vitamin B₁ and other substances in pollen germination is under way. Addition of indoleacetic acid in concentration ranging from 1/10 to 100 gamma per cc had no beneficial effect on germination of papaya pollen.

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⁴ H. Sherman and S. Smith, "Vitamins." Chemical Catalog Company, N. Y., 1931.

⁵ R. A. Dutcher, *Jour. Biol. Chem.*, 36: 551–555, 1918.

TABLE 1

GERMINATION OF PAPAYA POLLEN WITH AND WITHOUT TREATMENT WITH VITAMIN B₁

Variety	Length of test period Hrs.	Control Per cent. germination	Vitamin B ₁ * Per cent. germination	Percentage difference over controls
<i>C. quercifolia</i>	1	10	21	+ 110.0
	1½	25	37	+ 48.0
	2½	31	56	+ 80.6
	4½	71	80	+ 12.6
Fairchild	1	53	67	+ 26.4
	2½	67	77	+ 14.9
	4	75	88	+ 17.3
Florida	1	25	41	+ 64.0
	2	46	80	+ 73.9
	5	85	86	+ 1.1
Orlando	¾	35	32	+ 8.5
	1½	76	75	– 1.3
	2½	80	77	– 3.7

* 100 gamma per cc.

stances greater during the first two hours than after a four-hour period, which suggests that the main effect of the B₁ treatment was to speed up germination. A

¹ H. Von Mohl, *Beitrag zur Anatomie und Physiologie*. I. Bern. 1834.

² R. A. Brink, *Am. Jour. Bot.*, II: 283–294, 1924.

³ J. Bonner, *SCIENCE*, 85: 183, 1937; W. Robbins and M. Bartley, *SCIENCE*, 85: 246, 1937.

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