

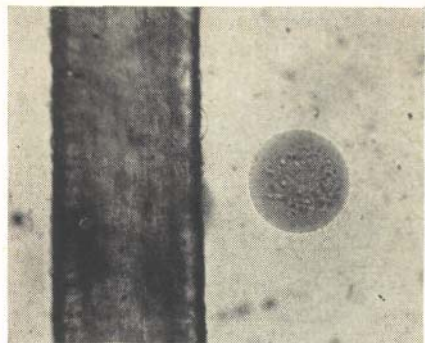
## SOME ASPECTS OF POLLINATION IN THE AVOCADO

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The normal avocado fruit results from a series of stages in the development and functioning of the floral parts. The sequence of development of these floral parts from the time of flower bud differentiation until full bloom has been described (5). The floral envelope or perianth parts appear first, followed by the development of the stamens and lastly by the formation of the pistil. When the floral parts are completed in development anthesis or pollen shed occurs, which can result in fecundation of the egg cell in the ovule and the subsequent stimulation to growth of the pistil, giving rise to the fruit. Several factors, any of which is lacking or which interferes with this complicated series of stages of development and functioning, may prevent normal fruit set and growth. The rather unusual biological aspects of dichogamy as exhibited by the avocado, described by Nirody (3), Stout (7), and others, perhaps have received more attention in its relation to fruit set than have other factors. More recently, variations in the floral behavior as affected by environment have been described by Bringhurst (1) and Lesley and Bringhurst (2).

The present investigation, based on some observation made as a part of a general study on the problem of fruit set in the avocado, has been focused on the pollen and its behavior. While avocado pollen in most instances appears normal in all respects, it has been found difficult to germinate on artificial media, but grows readily on the avocado stigma (4). Most pollens such as citrus, apple, peach, and others can be germinated readily on a 10 per cent sugar solution. The factors or conditions required for normal growth of avocado pollen in artificial media have not been determined as yet.



*Fig. 1. Avocado pollen grain compared in size with human hair.*

Preliminary observations (6) have indicated that all varieties of avocado grown commercially in California produce sufficient and abundant pollen for adequate fruit set,

if other factors are satisfactory. Thus, an average Fuerte flower in the coastal zone will produce, on the average, approximately 4743 pollen grains. The Fuerte at inland areas such as Vista or Fillmore may produce from 8000 to 9700 pollen grains per flower. Some varieties such as the Frey may have over 10,000 pollen grains per flower. As it requires only one grain to germinate on the stigma and subsequently grow down the style to fecundate the egg cell, it appears that the pollen production itself probably is not a limiting factor in fruit set in southern California.



Fig. 2. *Small portion of highly papillate stigmatic surface of avocado pistil.*

Among other factors which can influence the process of fruit development is the actual mechanical transfer of the pollen from its place of origin in the anther to the stigma. This action of transfer is technically called pollination. It may be by wind or animals such as insects and birds, or by actual mechanical contact of anthers with the stigmatic surface. The avocado probably is pollinated primarily by insects such as bees, although there is the possibility that some pollen is transferred by direct contact of anther and stigma. This latter situation was demonstrated at Los Angeles by enclosing a number of inflorescences in a cloth cage to exclude insect visitors for several days, after which samples of the flowers were taken and examined for the presence of pollen grains. A sample of 61 flowers taken from one of the caged limbs indicated that 50.8 per cent of the flowers had been pollinated with an average of 4.9 grains per stigma. In this sample, 31 per cent of the pollen had germinated. Comparable samples of flowers which were not protected against insect visitation show that an average of 87.5 to 94 per cent of the stigmas had been pollinated. This evidence clearly indicated that an adequate percentage of avocado stigmas receive pollen either by direct transfer or through the assistance of insect visitors to provide a good crop. Samples of flowers collected at Oxnard, where the Fuerte generally produces little or no crop, show that 78.5 per cent of the flowers had been pollinated and that 31.2 per cent of the grains were germinating.

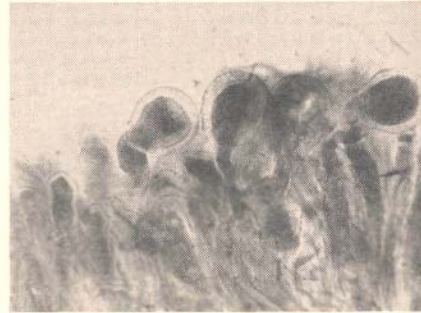


Fig. 3. *Avocado pollen grains germinating on stigma.*

The subsequent fate of the pollen after its transfer to the stigma, however, is another factor which is likewise of importance in fruit set. Samples of flowers taken from orchards in various localities have shown the presence of germinating pollen grains in sufficient quantities to suggest that pollen germination as an aspect of the process probably is not a limiting factor. Attempts have been made to follow the course of the pollen tube through the style to its ultimate goal, the ovule, but the technique has not yet been developed and perfected to ascertain some of the important details in the process. Some preliminary observations, however, are of interest. The pollen grain of Fuerte measures about 50 microns, which is approximately 0.002 of an inch in diameter.



Fig. 4. *Pollen tube which has penetrated deep into stigmatic and stylar tissue.*

The relative size of a pollen grain compared to a human hair is shown in figure 1. If this pollen grain is placed in a favorable situation on the highly papillate stigma (figure 2) it will germinate (figures 3, 4) by the development of a long pollen tube which grows down into the stigmatic and stylar tissue. Pollen grains not favorably located on the same stigma may fail to germinate.



Fig. 5. *Embryo in avocado fruit about  $\frac{1}{8}$ " long.*

Fuerte pollen placed on fresh stigmas of newly opened flowers has been observed to germinate through the style a distance of approximately 0.139 millimeters, or about 0.055 of an inch, in one hour on a warm, sunny day at Los Angeles. The average length of the style from stigma to the egg cell is approximately 4.0 mm. If a constant rate of pollen tube growth were maintained, a period of approximately 28.5 hours, or about one full day, would be required to effect fecundation following pollination. In another experiment, approximately 44 hours would have been required to effect fecundation, the temperature being 79° F. Nabal pollen appeared to germinate at a somewhat slower rate, and would require about 66 hours to traverse the same distance. Until a more reliable means of measuring pollen tube growth can be devised, however, and until the ultimate destiny of these tubes can be ascertained, discussion on this aspect of the problem will be mere speculation. The effects of temperature, humidity, pollen variety, and relative style length no doubt are factors in the process of fecundation; and each will have to be evaluated in order to enhance our knowledge of pollination in the avocado.

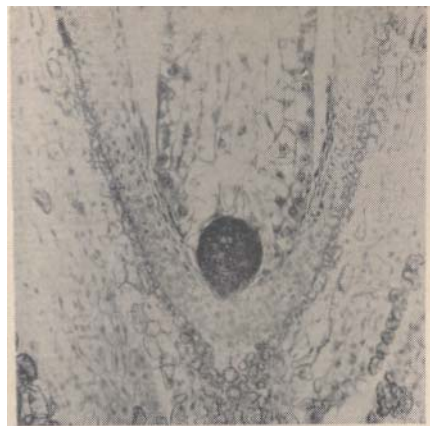


Fig. 6. *Detail of young avocado embryo showing general spherical nature and deep staining character.*

Preliminary studies on later stages following pollination and fecundation indicate that the small embryo which results is comprised of a spherical mass of deeply staining, highly concentrated cells (figure 6). This small cell mass eventually grows and undergoes

differentiation to form the normal seed. The embryo is at first a single cell which undergoes division to form two cells, which again divide to form four cells; and so by continued cell division a spherical mass of embryonic tissue is produced. An embryo in the spherical, undifferentiated stage, such as depicted in figure 5, measures about 0.0035 of an inch in diameter and is observed in a fruit approximately  $\frac{1}{8}$  of an inch long.

While the formation and development of the embryo generally results in fruit set, the delicate embryonic tissue is easily injured, and may be so adversely affected by unfavorable environmental conditions of low or high temperature, desiccation, or nutritional deficiencies that it will disintegrate or abort. Such a reaction probably will cause the small fruitlet to fall, or in some cases may result in the subsequent development of seedless fruits.

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