there is edema and a slight cellular infiltration with polymorphonuclears and monocytes of the mesoderm. Most striking are the numerous extensive hemorrhages within this layer. The ectodermal layer is usually covered with more or less cellular exudate in which the microorganism is present in large numbers. Necrosis of this layer does not occur except in those areas in which the blood supply in the underlying mesoderm is interfered with by hemorrhage or occlusion of the vessels. The most striking lesions are found in and around the blood vessels. The meningococcus invades the mesoderm and is found most abundantly in the areas of hemorrhage and in the lumen of the vessels. That a special affinity for the endothelial cells of the vessels obtains is evident from the fact that the microorganism is usually found in great numbers on the surface of these cells, often forming a complete collar around the inner surface of the vessel. It does not apparently grow intracellularly. Swelling and necrosis of vascular endothelium, with subsequent hemorrhage or thrombosis of the smaller vessels, result. The endodermal layer of the membrane is not greatly affected by the infection.

Within the embryo proper the microorganism produces lesions, particularly in the heart, meninges, kidneys and skin. All the lesions are vascular in origin and are evidently initiated by the lodging of the microorganism on the endothelium of the capillaries, with a resulting hemorrhage or thrombosis. In the heart numerous scattered foci of necrosis are found around small vessels and capillaries in which the diplococci can be demonstrated in close association with the endothelial cells. The meninges and choroid plexus show small areas of hemorrhage from small vessels in and around which numerous typical microorganisms can be found. The small capillaries of the kidney glomeruli are usually plugged with diplococci, so much so that an entire glomerulus often appears as a deep blue staining mass. In the skin and subcutaneous tissue hemorrhages are particularly frequent. The microorganisms are found here in abundance, growing on endothelial cells and among the escaped red blood cells. Vascular lesions of this type are occasionally observed in striated muscle, bone marrow and submucous tissues of the pharynx. In a few cases where multiplication of the microorganism within the embryo is particularly abundant the Kupffer cells of the liver are loaded with them.

Although these findings do not warrant any definite conclusion as to the pathogenesis of the earlier stages in the infection with the *Micrococcus meningitidis* in the human, it is well recognized that the purulent meningitis found at autopsy is an end stage in a disease which in its earlier stages is characterized by numerous pathological changes elsewhere in the body. The presence of the meningococci in the blood stream, sometimes as a chronic bacteremia, and the commonly recognized purpuric hemorrhages in the skin from which the microorganisms have been recovered by many observers indicate that the meninges may be secondarily invaded by meningococci transported by the blood stream.

In the experimental infection of the chick embryo the affinity of the meningococcus, once it has invaded the embryonic membrane, for the blood and vascular endothelium is the most striking feature. The ensuing lesions are all the direct result of this particular circumstance. The infection is essentially a septicemia.

Up to the present the study of infection by the *Micrococcus meningitidis* has been greatly hampered in that no suitable laboratory animal has been available in which the microorganism could be propagated in series away from its human host. Its relatively low pathogenicity has made necessary the use of exceptionally large doses in order to produce lethal effects in guinea pigs and mice. The clinical and pathological picture of cerebro-spinal meningitis has been obtained in monkeys only irregularly after direct inoculation of the central nervous system with large numbers of microorganisms.

Propagation of the *Micrococcus meningitidis* in the chick embryo is of additional interest because of the possibility of using this method for analyzing the effect of anti-sera and anti-toxins upon the infection. These and other immunological problems provide a wide field for investigation. They are now being studied, and our findings will be reported at a later date.

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## ENVIRONMENTAL CONDITIONS INFLUENCING THE DEVELOPMENT OF TOMATO POCKETS OR PUFFS

THE condition known as tomato "pockets" or "puffs" is a serious disease or abnormal condition of the fruit of this crop in the Atlantic and Gulf Coast States, and frequently in California. This abnormal condition of the fruit is more prevalent in the mid-winter and early spring crops grown in Florida, and especially in the early spring crops grown in Mississippi and Texas. Frequently 15 per cent. of the total crop is lost in Texas and often individual growers will lose as much as 65 per cent. of their crop. The malady is also of frequent occurrence on tomato crops grown in greenhouses in the north.

During the past five years an intensive study of the environmental factors, namely, soil moisture, relative proportion of mineral nutrients, temperature and length of day period, that may influence the development of tomato pockets has been made. A large amount of data has accumulated. These data represent a study of each individual plant, as to its daily and total transpiration rate and water requirement, and also, a study of the effects of sudden increases or decreases in soil moisture. The effects of sudden changes in temperature and in evaporation capacity of the air have also been studied. The detailed data are too extensive to present in tabular form in a résumé, so a summary of the major results is given.

The most important conditions within the plant and the associated factors that appeared to contribute to the pocketing of tomato fruits in these studies may be classified in three groups and are as follows:

(1) *No fertilization of ovules or typical parthenocarpy.* It should be recognized that the culture of tomatoes in the greenhouse under variable environmental conditions offers ideal conditions for producing pocketing of the fruit. Under ordinary circumstances pollen distribution is poor, but this was largely overcome by frequent agitation of the plants, by handling them in weighing to correct for water loss, in tagging the blossoms as they opened, in the tying of the plants to the stakes and in the taking of notes. In addition, the most prominent factors that contribute to sterility and parthenocarpy may be briefly noted: (a) abnormally long styles, a result of high temperatures; (b) slow germination of pollen tube, a result of low temperature; (c) slow growth rate of pollen tube, due to low temperature; (d) pollen abortion, due to low carbohydrate reserve, caused by high nitrogen, high soil moisture, high temperature and short-day light period; (e) ovule or embryo abortion, due to low nitrogen reserve, a result of low nitrogen, high soil moisture, high temperature and short-day light period. In these studies the many factors enumerated contributed strikingly to the development of pocketed fruit, especially when the plants were grown in the high and low temperature greenhouse units and when large amounts of nitrogen were applied.

(2) *Ovule of embryo abortion after normal fertilization.* The saturation or supersaturation of the soil appeared to cause marked changes in the normal metabolic, respiratory and transpiration activities of the plant, which in turn resulted in ovule or embryo abortion. Also, excessive drouth, accompanied by high transpiration, a condition that apparently results in endoxerosis, caused marked apparent changes in normal metabolic, respiratory and transpiration activities, and resulted in ovule and embryo abortion and the development of pockets.

(3) *Necrosis of vascular and placental tissue after fruit growth is well developed.* During any period of the growth of the plant, the saturation or supersaturation of the soil apparently stops almost entirely all transpiration; causes marked changes in color, the plants becoming chlorotic; and also interferes with the normal metabolic activities. These conditions apparently contribute largely to the appearance of necrosis of the vascular and placental tissues, which in turn leads to the development of pockets of the fruit of any age. Low soil moisture accompanied by high transpiration results in endoxerosis of the vascular and placental tissues. Sudden changes from optimum or high soil moisture to low soil moisture, accompanied by excessive transpiration, appeared to be the most drastic treatment of all that favored the development of pockets.

In these studies we are dealing with an environmental complex of many factors, as, for instance, soil moisture, soil nutrition, air temperature, light duration and the interrelation and interaction of these component factors, any one of which may become a limiting factor to normal plant growth, metabolic and respiratory activity, and thereby interfere with the normal development of tomato fruits. There is considerable suggested evidence that large amounts of superphosphate and only moderate amounts of nitrogen in the fertilizer reduce pockets by giving a nutritional balance conducive to more nearly normal seed development. The factors that can be observed and measured appear to bring about a general disturbance of the metabolism of the plant, causing a condition of suboxidation or endoxerosis; to affect the $Co_2$ and $O_2$ exchange, which, in turn, apparently leads to a visible necrosis of the vascular and placental tissues, thereby affecting ovule and embryo and placental development and normal fruit growth.

A more detailed report of this work is being prepared for publication at an early date.

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