or medulla of the adrenal (or both) are concerned can not be known from the available information. Among the animals that were subjected to vascular ligations there were some in which only the cortex degenerated, the medulla remaining intact. Whether or not functional integrity of the adrenal medulla may be altered yet present a normal appearance histologically is not known. However, the studies that are in progress may yield more definite information concerning the part played by the cortex or the medulla in the apparent interrelationship between the adrenal and parathyroid glands.

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HISTOLOGICAL CHANGES IN THE BONE MARROW OF THE DOG FOLLOWING AMIDOPYRINE ADMINISTRATION

THE suggestion that amidopyrine administration is causative of acute agranulocytosis of human beings has been advanced by Kracke,[1] Madison and Squiers,[2] Watkins,[3] Sturgis[4] and others. Attempts to cause granulopenia by administering amidopyrine to animals have not been attended by consistent results. Even the prolonged use of relatively large amounts of the drug has, in many instances, failed to cause perceptible evidence of disturbed granulopoiesis. From experiments of this type grave doubt has been cast upon the etiologic rôle of amidopyrine in acute granulopenia in man.

Experiments involving the oral administration of amidopyrine to dogs have been made. A 5 per cent. solution in water (Metz and Company, lot 1433) was employed and 0.3 gram per kilogram of the drug was given daily by stomach tube.

In a series of sixteen animals studied no instance of marked decrease of circulating granulocytes was encountered, although treatment was continued for four weeks or more. Erythropenia of varying degree occurred.

Histological study of the femoral bone marrows of the treated animals, however, revealed striking changes, which gave evidence that the drug does affect the formation of granulocytes, even though not to a degree which is reflected in a materially decreased number of granular leukocytes in the circulating blood. A well-defined suppression of maturation of the hematopoietic elements occurs. Granulocytes are decreased in numbers or almost completely absent. The number of young, relatively undifferentiated cells is increased. Many erythroblasts and myeloblasts are present, as are cells of an even more primitive type; more adult forms are rare. In certain more advanced cases the orderly arrangement of the bone marrow structure into hematopoietic islands has been disturbed.

From the observations reported it appears that amidopyrine orally administered may exert a toxic effect upon the bone marrow, with little or no evidence of the fact in the circulating granular elements of the blood.

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[1] R. R. Kracke and F. T. Parker, *Jour. Lab. and Clin. Med.*, 19: 799, 1934.

[2] F. W. Madison and T. L. Squier, *Jour. Amer. Med. Asso.*, 102: 755, 1934.

[3] C. H. Watkins, *Proc. Staff Meet, Mayo Clinic*, 8: 713, 1933.

[4] C. C. Sturgis, *Proc. Asso. Am. Phys.*, May, 1934.

INSECTICIDALLY INDUCED IMMUNITY IN PLANTS TO SUCKING INSECTS

THE word immunity has been used in different ways and given various meanings by many workers. A recent article by Kenneth S. Chester[1] summarizes what is known in this field regarding plants and he defines immunity in plants as "the capability of withstanding infection acquired by the host either through the introduction of protective chemical substances of biological origin (passive) or through the elaboration of such protective substances in the host as a result of stimulation by the parasite." He states further: "It must be understood that the same principles as apply to the host-parasite relationship apply also to the relation between two symbionts or between a plant and introduced substances of a stimulative nature such as toxins or proteins which if not counteracted or inactivated would have a deleterious effect upon the plant."

Insecticides have been considered until very recently as materials which contained physical or chemical properties which produced toxic effects upon insects directly. It has been a common belief that in order to kill insects which obtain their food by sucking plant juices it is necessary to use insecticides which are known as "contact" materials and which have a direct insecticidal action upon the insect by the liberation of gases or other corrosive and penetrative effect upon the body of the insect. Such materials as nicotine sulfate and pyrethrum are known to produce toxic effects in this way. The plant has not been considered as a factor in insect control and has been given consideration only as it might be injured by chemical materials which were applied in attempting to control insects.

In 1926 experiments were undertaken to control the potato leafhopper (*Empoasca fabae* Harris) on bean and potato. Field experiments soon indicated that certain materials when applied to these plants in

[1] *Quart. Rev. Biol.*, 8: 131, June, 1933.

the field gave no immediate results as toxic agents and had no immediate effect upon the reduction of these populations, but in the course of three to five days after their application they reduced these populations remarkably, causing motor paralysis of the insects and death. The effectiveness of these materials continued as the eggs in the plant tissues continued to hatch over a period of several days and the young leafhoppers, upon hatching, began to feed. A series of experiments then carried out by special techniques showed conclusively that these materials had no effect upon the insects directly. But if they were applied to the plant and the insects were then placed upon the treated plant, from a few hours to several days afterward, and were permitted to feed, these insects would die in the manner mentioned above. With the materials used only local areas of the plant were affected in this manner and the plant system as a whole was not affected unless the plant foliage was covered with these materials. This apparently is in keeping with the factor of immunity in plants in general, since the cell is the seat of immunity and the system is usually not affected because of the absence of a circulatory system such as we find in animals.

This immunity effect or plant conditioning was first produced by Bordeaux mixtures and other copper compounds and was reported in 1929[2] and 1930.[3] At this time the writer referred to this condition as a residual toxicity effect. More recently a similar type of induced immunity in plants has been produced by various sulfur materials. The apparent killing effect produced upon the insect is the same as in the case of copper compounds, although the effect upon the plant may be entirely different in case of these two materials.

The results obtained with sulfur were first reported[4] in 1933 when Dr. N. F. Howard, speaking before the Ohio Horticultural Society, cited the work which had been carried on during the preceding season (1932) by the author, under his direction. A more complete report[5] was made by Dr. Howard and the author in January, 1934. More recently it has been found that practically all types of sulfurs will produce this effect in varying degrees upon these plants, although the elemental sulfur materials and those forms in which the sulfur is not changed chemically by physical and chemical processes have given the best results. For instance, dusting sulfur, "dry mix," dry wettable and under some conditions flotation sulfur, will give better results than liquid lime sulfur and colloidal sulfur when used to control the potato leafhopper on bean plants.

A recent article by List and Daniels,[6] of Colorado, reports a similar control of the potato psyllid upon potato and a similar residual effect upon the potato plant as that which has previously been produced by the writer with both Bordeaux mixture and sulfur materials on potato and bean.

The psyllid is a sucking insect closely related to the potato leafhopper and apparently is affected in the same manner by inducing immunity in the plant by chemical treatments.

Although insoluble when placed upon the plant tissue, these materials in some way either cause the plant to produce abnormal quantities of a toxic material which may possibly be produced normally by the plant only in minute quantities, or the chemical effect upon the plant may be direct by causing the character of the sap to change remarkably and the general rate of metabolism to change by the presence of extremely small amounts of the insecticide which has been absorbed in some form by the plant. Experimental work has given evidence of both possibilities.

Materials of this type can scarcely be classified as contact insecticides in the same manner as those materials which kill the insect by direct effect upon the insect's body. It seems necessary, therefore, to classify insecticides which affect insects of this type in two distinct groups: First, those which we have previously designated as contact insecticides and whose toxicity value refers to the direct insecticidal action upon the insect through contact; and, second, those which might be said to have a residual toxicity value which is attributed to an indirect effect since the toxicity is accomplished by a conditioning or partial conditioning of the plant (accessory to a certain possible inherent partial immunity) to produce a killing effect upon the insect.

Such a principle of toxic effect or insecticidal relationship—that of working through the plant and producing induced insecticidal immunity in the plant—has not received much positive support or serious consideration until this recent work of the past eight years has demonstrated conclusively these results.

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[2] *Jour. Econ. Ent.*, 22: 345, April, 1929.

[3] *Jour. Econ. Ent.*, 23: 383, April, 1930.

[4] Proceedings of the Ohio Vegetable Growers Association, p. 141, March, 1933.

[5] *Florida Grower*, 42: 8, 1934.

PHYSICAL RELATIONSHIPS BETWEEN MARSH AREAS AND LAKE LEVELS

IT seems to be quite a common assumption that receding lake levels are due to deforestation and cycle changes in precipitation. Similarly, marsh levels are usually supposed to be dependent upon the levels of adjacent bodies of water and streams. The writer is

[6] SCIENCE, n. s., 79: 2039, January 26, 1934.