Hungry grasshoppers were exposed to small quantities of these baits in small cages against a check made omitting the poison, and they fed on all of them. This would indicate that both the single and double strength Epsom salts baits were acceptable to grasshoppers. They died in the Epsom salts cages somewhat faster than in the check cages of unpoisoned bran mash, but that is regarded as of little significance.

Observations on the caged hoppers from the experimental plots after the forty-eight-hour period when the last counts were made showed that there was no larger death loss in the Epsom salts cages than in the check cages. In other words, Epsom salts did not kill the hoppers after forty-eight hours.

Cabbage, sweet corn, tomatoes, string beans and squash foliage were sprayed with a nearly saturated solution of Epsom salts (2⅔ oz. in 4 oz. or 100 cc of water at 70° F.) and no injury was done to the plants. Cabbage loopers and cabbage worms on the cabbage were not killed by the spray.

The three series of sowings indicate that Epsom salts used in bran mixture grasshopper bait was uniformly unsuccessful. Even double the recommended amount of Epsom salts in bait mixtures was ineffective. In these tests, Epsom salts was without value for destroying grasshoppers.

A field test of Epsom salts plus calcium chloride against the standard Paris green bait was made in a heavily infested field of corn near Atchison, Kansas, on July 14 in company with Dr. Harry Miller, of The Chemical Foundation of Kansas. A sowing of 120 pounds of bait according to Dr. Miller's modification of the Frings' formula of 20 per cent. magnesium sulfate (Dow Chemical Company) and 5 per cent. crude calcium chloride against one hundred pounds of Paris green bait gave a net kill of 4.2 per cent. at forty-eight hours against 56.9 per cent. for Paris green.

A survey of the literature offers little evidence that magnesium sulfate has any value as an insecticide whatsoever. There is not a single really impressive field control demonstration recorded. The small test by Hawkins against the wheat wire worm mentioned by the Frings' was apparently not regarded as significant by him, for he drew no practical conclusions from it.

The action of magnesium sulfate on the lower animals is primarily anesthetic. There was no cathartic action observed on the grasshoppers.

It is unfortunate that the extensive publicity on the supposed value of Epsom salts resulted in widespread use of a material that appears to be ineffective for the purpose. It is serious, because many persons may have their faith in the standard bait method weakened. At the present time, only sodium arsenite, white arsenic, gray or crude arsenic, Paris green, sodium fluoride and sodium fluosilicate in baits give anything approaching satisfactory control of hoppers. For the present at least, Epsom salts can not be recommended as a satisfactory control for any insect.

ROGER C. SMITH
KANSAS AGRICULTURAL EXPERIMENT STATION,
MANHATTAN, KANSAS

FITNESS, SULFANILAMIDE AND PNEUMOCOCCUS INFECTION IN THE RABBIT

THIS is a preliminary report of an investigation of the extent to which the effectiveness of sulfanilamide in experimental pneumococcus infection, in the rabbit, may be determined by factors reflected in the fitness rating.

The fitness rating is an index of condition and of capacity for resistance. Rabbits with high fitness ratings accomplish the removal of intravenously injected pneumococci from the blood more rapidly than rabbits with ratings appreciably lower.[1]

Transient improvement in fitness rating has been obtained in 70 per cent. of sixty-three rabbits given extract of adrenal cortex, extract of liver, vitamin B_1 or vitamin C. Intravenous injection of the latter substance, ten minutes before intravenous infection with type I pneumococcus, has been followed by substantial increase in capacity for the removal of pneumococci from the blood. Seven out of eleven rabbits, so treated, were enabled to reach a negative blood culture in one-half hour, as compared with a proportion of three out of twelve in a series of comparable controls.

The percentage recovery in a series of forty-four rabbits infected intradermally with a virulent strain of type I pneumococcus was as follows: 33 per cent. for six untreated, control rabbits with fitness ratings above the critical level of 0.6; 86 per cent. for seven rabbits of equivalent rating, given sulfanilamide at the beginning of the second and sixth hours of infection and at six-hour intervals thereafter; 100 per cent. in five equivalent rabbits given vitamin C in addition to sulfanilamide at the times stated; 0 per cent. for seven untreated, control rabbits with fitness ratings between 0.6 and 0.4; 25 per cent. for eight rabbits comparably low-grade but given sulfanilamide; 71 per cent. for seven similar rabbits given sulfanilamide plus vitamin C; 100 per cent. for four, only, equivalent rabbits given sulfanilamide plus either liver extract or vitamin B_1.

The contribution of the sulfanilamide was apparent in the increase in percentage survival in the higher

[1] A. Locke, *Jour. Infect. Dis.*, 60: 106, 1937.

fitness groups from 33 per cent., in the absence of treatment, to 86 per cent., when given sulfanilamide. The contribution of the adjunctive supporting treatment was apparent in the increase in percentage survival in the lower fitness groups from 25 per cent., with sulfanilamide alone, to 71–100 per cent. with sulfanilamide plus vitamin C, vitamin B_1 or liver extract.

The rabbits which survived were, almost altogether, those able to hold a negative blood culture, in spite of lesions at site of injection, as large, at twenty-four hours, as were observed in the controls. The percentage coming through to recovery without persisting fever or substantial weight loss was, for the higher fitness group receiving no treatment, sulfanilamide alone, and sulfanilamide plus adjuvant, respectively: 0, 57 and 60; for the corresponding lower fitness groups: 0, 25 and 64.

Treatment with sulfanilamide and especially with sulfanilamide plus fitness-promoting adjuvant tends to keep the blood stream clear enough of pneumococci invading from infected foci, in the rabbit, to permit the natural defensive forces to get an upper hand.

Detailed report will be deferred until completion of studies under way on optimum dosage and timing, limitations imposed by fitness-impairing potentialities of sulfanilamide itself; and considerations necessary because of differences in rate of conjugation of sulfanilamide to a less active derivative, in rabbits of divergent fitness rating.

ARTHUR LOCKE
R. B. LOCKE
R. J. BRAGDON
R. R. MELLON
THE WESTERN PENNSYLVANIA HOSPITAL
PITTSBURGH

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTRIC CARDIOMETER

THE recording of the heart beat by the commonly used pneumatic method is not fully satisfactory because the adjustment of the apparatus is critical, and comparatively slight bodily movements on the part of the subject are sufficient to interfere with the registering. This latter defect becomes particularly serious during studies in the physiology of exercise, and in psychological experiments involving the determination of the cardiac rate immediately following strong stimuli, when movement is apt to occur.

Boas[1] seems to have been the first investigator to employ the action potential of the heart for recording purposes during exercise. He made use of a battery-operated vacuum tube amplifier controlling a sensitive relay, which actuated a second relay carrying contacts for operating an electric counter and pen recorder. This apparatus was found to operate perfectly when the various contacts, relays and amplification controls were properly adjusted, provided that the subject remained well insulated from the ground, did not touch other persons and did not engage in certain types of generalized muscular activity. Benedict, Lee and Striech[2] used the Boas apparatus successfully in connection with the bicycle ergometer.

Recent improvements in vacuum tube design have made it possible to develop a similar apparatus which operates from the 60-cycle lighting circuit, is rugged and non-critical in adjustment and apparently is free from the defects of the Boas instrument. The new apparatus is $9 \times 11 \times 17$ inches in size, weighs approximately 30 pounds when mounted in a steel cabinet and is self-contained.

The electrode system is similar to the one used by Boas, with the exception that the indifferent contact consists of a wire placed in the mouth instead of a cup electrode on the right side of the chest. It is bent in such a manner that it is self-retaining and does not interfere with breathing. This contact is connected to the grounded shield of a rubber-covered microphone cable, and the active electrode is connected through the center wire of this cable to the amplifier shown in the figure. The active electrode, which may be a metal plate covered with moistened cotton or kaolin paste, is placed over the apex of the heart.

The amplifier is of the four-stage resistance-coupled type, designed by the writer for studying nerve action potentials. Its over-all voltage gain is well over one million, with a noise level of about four microvolts. A double pole switch (S) is provided for inserting a band-pass filter into the input and output of one of the stages. Experimentally, the filter seems most effective for cardiometric work when both sections are resonated at 20 cycles. This may be accomplished by using 500 H. inductors shunted with 0.1 Mfd. capacitors. The output of the amplifier actuates a small copper oxide milliammeter having a light weight pointer, and also excites the grid of a gas-triode tube. When the grid of this tube becomes relatively positive (this occurs at each heart beat) anode current continuously flows through the coil of the electric counter until the anode potential is reduced below the ionization point. The amplified cardiac potential, therefore, simply acts as a trigger to start the anode current in this tube. Once started, the current flow maintains

[1] E. P. Boas, *Arch. Int. Med.*, 41: 403, 1928.
[2] F. G. Benedict, R. C. Lee and F. Striech, *Arbeitsphysiologie*, 8: 266, 1934.