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Studies in the Selection for Susceptibility and Resistance to Anaphylactic Shock in Guinea Pigs

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STUDIES IN THE SELECTION FOR SUSCEPTIBILITY AND RESISTANCE TO ANAPHYLACTIC SHOCK IN GUINEA PIGS

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MATERIAL AND TECHNIQUE

In 1927 the foundation stock for this experiment was picked at random from the guinea pig colony of the Genetics Department at Iowa State College. Since then three generations of individuals, selected both for resistance and susceptibility to protein reaction, have been obtained.

Each animal received a sensitizing dose of 0.1 cc. of normal horse serum thirty days after birth. At the age of sixty days a second injection of 6 cc. of normal horse serum was administered, both injections being intraperitoneal. In this manner there was produced a typical anaphylactic shock such as described by Zinsser (1923) and others. The intensity of the individual's reaction to this foreign protein was measured mostly by its minimum rectal temperature after the administration of the shock dose. Temperatures were taken thirty minutes before the shock dose, at the time of the shock dose, and at thirty minute intervals for three hours after its administration. From the data thus obtained, individuals surviving and having minimum rectal temperatures of 97°F. and above after the shock, and coming from matings having like records, were kept for the perpetuation of the resistant strain. The animals surviving and having minimum rectal temperatures of 94°F. and below, after the shock, and coming from low matings, that is where both parents have shown low temperatures, were reserved for the susceptible strain. Individuals falling between 94°F. and 97°F. were discarded. Due to the fact that the exact temperatures resulting from the shock were difficult to determine because of so many variables, only animals in the two extremes of these high and low categories were kept for breeding purposes.

The rectal temperature was taken as typifying the intensity of the individual's reaction for, according to Zinsser (1923, page 433), "The fall of temperature first described by H. Pfeiffer, however, seems to be an occurrence which, though standing in no causative relation to the symptoms as a whole, is so constant and

well marked that it has been taken by a number of workers as one of the necessary criteria for the characterization of the anaphylactic condition." This agrees with the observations in this experiment. The individual that runs a low temperature shows very definitely other conditions which are characteristic of severe anaphylactic shock.

Results

In the control stock (Table I), consisting of 163 animals having no known hereditary background of anaphylaxis, individuals having minimum temperatures of 97°F. and above included 15.3 per cent of the total tested population. Those between 94°F. and 97°F. included 24.0 per cent of the total tested population, while 31.3 per cent of the individuals had temperatures of 94°F. and below. The mortality percentage in the control stock was 29.4 per cent. The minimum temperature of those dying was not recorded because of the natural drop occurring at death.

The resistant strain (Table I), including 143 individuals from three selected generations, shows that 36.3 per cent of all animals tested had minimum temperatures of 97°F. and above, an increase of over 100 per cent above the control animals. Thirteen and nine-tenths per cent of the individuals went between 94°F. and 97°F., and 25.9 per cent were 94°F. and below. The mortality of the group went down to 23.9 per cent, a drop of 5.5 per cent from the controls. The minimum temperatures of those dying were disregarded. These percentages are determined on the resistant population as a whole starting with the first selected generation.

Table I — Percentages of those individuals having minimum rectal temperatures of 97° F. and above, between 97° F. and 94° F., and 94° F. and below in the control stock, resistant strain, and susceptible strain. Percentages are based on total number of animals tested in each group

Stock	No. of Individuals	Temperatures			Mortality
		97° F. and Above	97° F. to 94° F.	94° F. and Below	
Control	163	15.3	24.0	31.3	29.4
Resistant Strain	143	36.3	13.9	25.9	23.9
Susceptible Strain	116	27.6	12.9	17.2	42.3

In the susceptible line (Table I), having a total of 116 animals from three generations, the high class included 27.6 per cent of the individuals tested, the medium, namely between 94°F. and 97°F., 12.9 per cent, and the low class, 94°F. and below, only 17.2 per cent of the total number of animals tested. While selection in

the susceptible strain has not produced significant percentage differences between the high and low temperature classes, still the mortality percentage increased 12.9 per cent, this being 42.3 per cent of the total susceptible individuals tested.

While the percentage differences between the control stock and the two selected strains are in some cases not statistically significant, there is an increased per cent of individuals over the control group having minimum rectal temperatures of 97°F. and above in the resistant strain. Also, in the susceptible strain there is an increase of mortality above the control stock. The differences in mortality between resistant and susceptible lines is still greater. Further generations will tell whether these differences are biologically significant. This being the case, assuming that there is a significant change, it would appear at present that mortality is a better indication of susceptibility than temperature, although the criterion for selection in the low line has been mainly minimum rectal temperature. This basis of selection in the susceptible strain may account for the high percentage of individuals having temperatures of 97°F. and above in this group. The mere fact that an animal survives the shock dose of serum shows that it has some ability to resist the shock. Naturally, then, some of the progeny from the survivors in the susceptible line will give a high temperature when tested, while a large majority of the would-be-low-reactors, die. This leaves the percentage of low temperatures small in the susceptible line. In view of these facts, the breeding program has been changed in the susceptible line to a progeny test scheme in which animals are allowed to reproduce before they are tested. In this plan selection will be made from mortality as well as temperature records.

By generations the results become more variable. In the resistant line there is a trend upward of the minimum temperature from 97°F. and above as represented in fig. I. The temperatures, from 94°F. and below, and mortality show a slight general decline.

In the susceptible strain, treatment from the standpoint of generations emphasizes the inconsistencies within this line. The conclusion is, as stated in an earlier part of this paper, that the same type of breeding program will not work for both selected lines. In the susceptible line it is apparently necessary to take into account another factor other than minimum temperature, probably mortality.

Figure II shows that the survivors of the S_1 generation carried the potentialities of high and low temperatures rather than a high

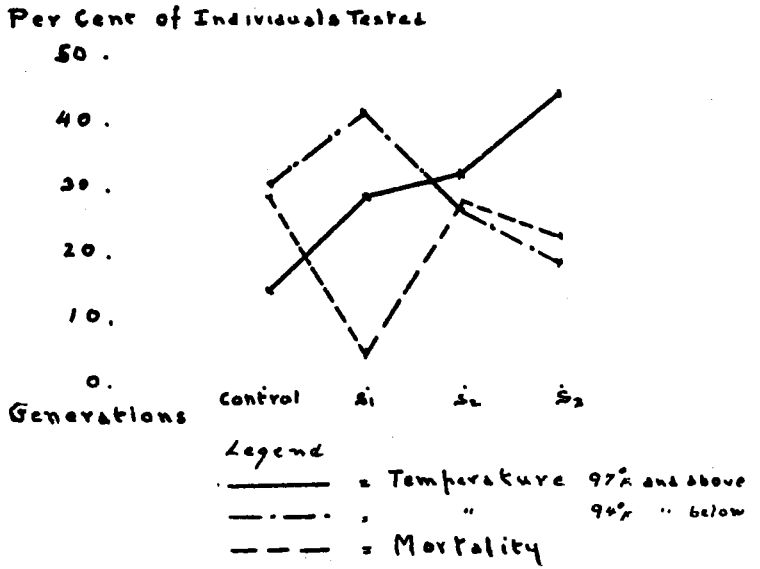

Fig. 1. The trend of temperatures, 97°F. and above, 94°F. and below, and mortality in the resistant strain.

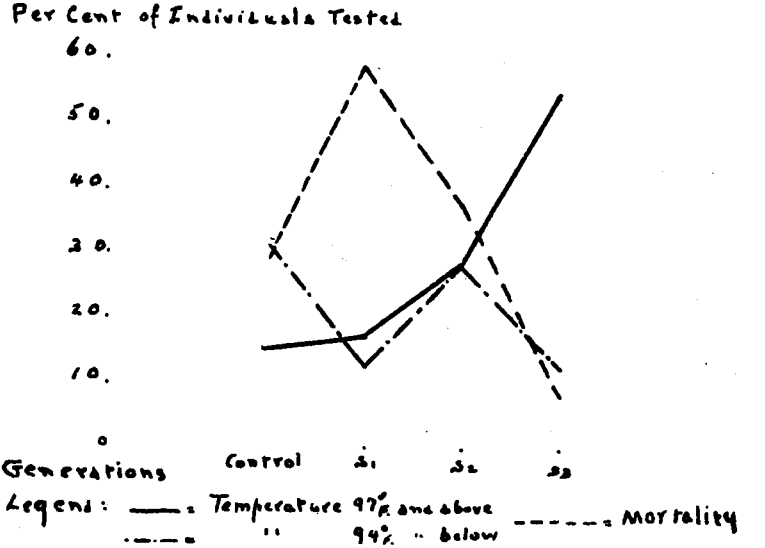

Fig. 2. The trend of temperatures 97°F. and above, 94°F. and below, and mortality in the susceptible strain.

percentage of mortality. These survivors in the S_1 when mated gave to their offspring in the S_2 generation still more ability to resist the shock. In the S_3 generation this quality of resistance is accentuated even more, for the mortality percentage is below that of the other two classes. This substantiates the statement mentioned before, namely, the fact that animals survive is evidence that they have the ability to resist the shock dose. Therefore, some of their progeny also carry this resistance.

CONCLUSION

It may be possible by selection to establish two strains of guinea pigs, one resistant, the other susceptible to anaphylactic shock. However, the same technique of selection cannot be effectively used for both the resistant and susceptible strains.

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