nistic materialism becomes a menace." The present world catastrophe is the upshot.

The author is neither a biologist nor an anti-evolutionist. He is an outstanding historian and philosopher interested in the development of the intellectual climate of our time. Asking Professor Barzun's forgiveness, we shall consider only the part of his book dealing with Darwin. To many a biologist his treatment of Darwin will seem irreverent to the point of blasphemy. But the author's arguments can not be shrugged off so easily. Darwin's theory of evolution has gained a general acceptance, while theories of his predecessors had failed to do so. We have been taught that the cause of Darwin's success lies in the mass of evidence carefully marshalled by Darwin in support of his views. The author does not deny this explanation. However, he points out that the intellectual tastes of Darwin's age were peculiarly favorable for adoption of just that kind of a theory. "To scientists and laymen alike, the appeal of natural selection was manifold. It had the persuasiveness of 'small doses'; it was entirely automatic, doing away with both the religious will of a creator and the Lamarckian will of his creatures; it substituted a 'true cause' for the 'metaphysical' sort of explanation; lastly, natural selection was an exact parallel in nature to the kind of individual competition familiar to every one in the social world of man." In a period of imperialistic expansion the theory of natural selection lent itself to misuse to confer a semblance of respectability on dastardly political doctrines. "Darwin did not invent the Machiavellian image that the world is the playground of the lion and the fox, but thousands discovered that he had transformed political science. Their own tendencies to act like lions and foxes thereby became irresistible 'laws of nature' and 'factors of progress,' while moral arguments against them were dubbed 'pre-scientific.'"

It is to be regretted that Professor Barzun did not confine himself solely to historical criticism and could not resist the temptation to judge biological theories on their scientific merits. The theory of natural selection has certainly been debased, but it happens to be, in its modern form, a description of a well-established agent of evolutionary change. It does not require life-and-death utility of the evolutionarily effective variants, it is perfectly compatible with the "orderliness in the facts of heredity and variation," and it is certainly much more than "the right wrong idea" to convince the uninitiated in the truthfulness of the proposition that organic evolution has taken and is taking place. No references to authorities, however well chosen, can discredit natural selection in its proper sphere. In the reviewer's opinion the author's emphasis on the fact that Darwin was by no means the first evolutionist, and that he has, probably unconsciously, used certain ideas of his predecessors without proper acknowledgment, hardly detracts much from Darwin's stature as a scientist. After all is said and done, it is Darwin who has advanced the first evolution theory which has on the whole withstood the experimental tests imposed on it and which has developed into the modern edifice. True, it has changed greatly in the process, but so has physics since the times of Galileo and Newton.

The usefulness of the book of Professor Barzun stems from the fact that, as he correctly remarks, "science is not only man-made but man-used." Neither a biologist nor a layman can be disinterested in the uses to which the product of the scientific work is put. In this realm the evaluation can best be made by a historian. The brilliantly written and thought-provoking book of Professor Barzun will certainly repay a careful reading and contemplation.

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SPECIAL ARTICLES

GROWTH STIMULATION BY SULFANILAMIDE IN LOW CONCENTRATION

THE bacteriologist is well acquainted with the growth-stimulating effect of toxic materials in low concentration. Probably the best-known substances in this respect are the toxic cations on which extensive exact quantitative studies have been made.[1] But a wide variety of dissimilar substances have been noted to show the same stimulative action. Fred[2] has recorded observations on ether and salvarsan. Rahn[3] quotes Hofmann, who studied the phenomenon for lysol, atropin, saponin, malichite green, etc. More recently Beckwith and Geary have reported on indol-3-acetic acid.[4] There are a great number of other published observations.

Inasmuch as no such work has been reported in connection with sulfanilamide or other therapeutically significant sulfa drugs a study of sulfanilamide was undertaken.[4a] A qualitative method, the agar cup plate

[1] Margaret Hotchkiss, *Jour. Bact.*, 8: 141, 1923.

[2] E. B. Fred, *Zentralbl. f. Bakt.* (abt. 2), 31: 185, 1912.

[3] O. Rahn, *Physiology of Bacteria,* 1932, Blakiston, Philadelphia.

[4] T. D. Beckwith and E. M. Geary, *Jour. Inf. Dis.*, 66: 78, 1940.

[4a] Since submitting this paper a study has appeared (SCIENCE, 95: 104, 1942) by H. A. Johnson reporting stimulative action on luminous bacteria. The present data can be interpreted to support Johnson's hypothesis that sulfa-drug action is related to general theories of

technic,[5] was employed. In addition some tests were run by placing either 5-grain or 7.5-grain sulfanilamide tablets in the center of a sterile petri plate and pouring agar inoculated with a milliliter of an 18-hour broth culture of bacteria or 48-hour broth culture of yeast. Depending on the organism, the tablet or agar cup filled with sulfanilamide was surrounded by a zone of no growth or partial growth. At the edge of the area of inhibited growth stimulation was indicated by the appearance of a zone of growth heavier than elsewhere in the plate. Control plates were poured to check the distribution of inoculum in the agar and the possible influence of technique. For the bacteria, a beef infusion to which was added 2 per cent. sodium chloride, 1 per cent. Difco-peptone and 0.05 per cent. glucose was used. This was adjusted to pH 7.6. Czepak's medium was employed for the yeasts studied.

The following bacteria from our stock culture collection showed no zone of stimulation: *Lactobacillus acidophilus, Streptococcus fecalis, S. zymogenes* (both a proteolytic and non-proteolytic strain), *S. durans, S. mastiditis, S. pyogenes group A* (strains Dochez, J 17A4), two strains of *S. lactis, Escherichia coli, Aerobacter cloacae, Salmonella schottmulleri, S. paratyphi, Shigella gallinarum, Klebsiella ozaenae, Staphylococcus citreus, S. albus, Sarcina ventriculi, Micrococcus nitrificans.* Irregular results were given by *Aerobacter aerogenes* and two strains of *Eberthella typhi.*

Stimulation was exhibited by a strain of *Pseudomonas aeruginosae* and *Alkaligenes fecalis.*

Of 29 strains of aerobic spore-forming bacteria tested, 12 which represented strains of *Bacillus vulgatus, B. mesentericus* and *B. mycoides,* showed zones of stimulation. Gram stains prepared from cells in the stimulation zone and from normal growth revealed no obvious or systematic differences. In one case cells from the stimulation zone showed a greater number of chain formations. In another case the cells were larger.

Of 12 strains of *Bacillus vulgatus* (identified according to published criteria[6]) 7 showed a zone of stimulation. Thus the effect seems to be an intra-species one rather than related to the species.

The zone of stimulation did not always appear in the early stages of growth. Often it became visible only after 72 hours of growth.

In the case of the yeasts, an unidentified strain of *Torulaspora* showed a zone of slight stimulation. The following were not stimulated: *Torula glutinis, T. cremoris, Saccharomyces cerevisiae, S. ellipsoideus, Willia anomala, Zygosaccharomyces bailii, Oidium lactis, Monilia nigra.* The yeasts were incubated at room temperature and observed at the end of 72 hours and 7 days.

Will an organism manifest stimulation by one toxic substance and not another? Apparently it will, as tests run on *Escherichia coli, Bacillus subtilis, Willia anomala* and a few others gave a stimulation zone with bichloride of mercury and not with sulfanilamide.

Of late there has been renewed interest in the therapeutic efficacy of anti-bacterial substances produced by microorganisms. It would be informative to know whether they too exhibit a stimulative action in low concentrations. Waksman[7] in a review of the subject of bacterial antagonism makes no mention that the question has been considered. Yet it is evident that for one of these substances, actinomycin, a stimulative effect is exerted on *Bacillus mycoides* and *Sarcina lutea* as photos published in a paper[8] describing *Actinomyces antibioticus* clearly show zones of stimulation.

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narcosis, and possibly bring some of the biologically produced antagonistic substances within the ken of narcotic mechanisms.

[5] U. S. Department of Agriculture Circular No. 198, 1931.

[6] C. Lamanna, *Jour. Inf. Dis.*, 67: 193, 1940.

INCREASED LIVER ARGINASE ON ADMINISTRATION OF ADRENOCORTICAL AND CORTICOTROPIC HORMONES[1]

IT has been shown in recent years that dietary conditions may affect the arginase content of the liver of rats. Thus, as would perhaps be expected, factors leading to increased deamination and gluconeogenesis, such as high protein diets or fasting, were found to increase liver arginase.[2] An investigation of the action on liver arginase of hormones known to control the rate of gluconeogenesis appeared indicated.

Liver arginase was determined in several groups of hypophysectomized rats which had received 15 daily injections of pituitary extracts high in adrenocorticotropic activity (ACT H),[3] and in one group which had been similarly treated with cortin (Adrenal Cortical Extract, Upjohn).[4] In each case a considerable

[7] S. A. Waksman, *Bact. Rev.*, 5: 231, 1941.

[8] S. A. Waksman and H. B. Woodruff, *Jour. Bact.*, 42: 231 (fig. 1), 1941.

[1] Aided by grants from the Board of Research of the University of California and the Rockefeller Foundation, New York City, and Parke Davis and Company, Detroit, Michigan. We wish to acknowledge assistance from the Work Projects Administration, Project No. OP-65-1-08, Unit A-5.

[2] D. H. Lightbody and A. Kleinman, *Jour. Biol. Chem.*, 129: 71, 1939; *Proc. Soc. Exp. Biol. and Med.*, 45: 25, 1940.

[3] Prepared according to an as yet unpublished method of C. H. Li, of this laboratory.

[4] The determination and the calculation of arginase unitage were performed according to Edlbacher (S. Edlbacher and H. Röthler, *Zeits. physiol. chem.* (Hoppe-