use of any practical tool is not delayed for logical reasons nor because of difficulty in proof. If the conclusions of a theorem are comprehensible to a student without proof or if the proof would seem to him superfluous or unnecessary then the demonstration of the result is omitted. Thus the reader may gain manipulative power even before he has reached a stage where he can appreciate all the reasoning behind the developments. A man may drive a motor car skilfully without being able to repair the motor or he may be a first-rate radio mechanic without understanding Maxwell's theory of electric waves. A good notion of the author's point of view may be had from the following quotation from his preface:

> The attempt to prove everything often leads to the use of roundabout methods in the beginning of a book. This fixes inefficient techniques in the reader's mind, even when better methods are presented later. In this book the author has given the simplest known method of solving each type of problem the first time it appears, even when this means quoting a theorem from an advanced branch of mathematics without proof.

Some idea of the material covered may be had from the following list of chapter headings: I. Elementary Functions for Complex Values and Taylor's Series; II. Partial Differentiation and Implicit Functions; III. Vectors, Curves, and Surfaces in Space; IV. Integration. The Definite Integral Multiple Integrals; V. Line Integrals. Complex Variables; VI. The Gamma Function and Related Definite Integrals; VII. Elliptic Integrals; VIII. Vector Analysis; IX. Differential Equations; X. Legendre Polynomials and Bessel Functions; XI. Fourier Series and Partial Differential Equations; XII. The Calculus of Variations and LaGrange's Equations.

Let us call attention to certain special features of the book. It is arranged in such a way as to be especially useful for self-study. The introduction of review material has already been referred to. There is a great wealth of fine exercises and problems, averaging about one hundred per chapter. Answers to all these are given at the back of the book. Where the solution of a problem departs materially from the methods of the text hints for a successful attack are given. At the end of each chapter is a section offering suggestions for further study. In case proofs have been omitted in the text reference to a suitable source for them is given. In many cases the omissions may be supplied from the author's own text, "Treatise on Advanced Calculus," John Wiley and Sons, 1940. Attention should also be called to a new method of reduction of elliptic integrals of first and second kinds to the tabulated functions. As would be expected in such a book there are very many applications from the physical sciences for any theory introduced. For example, in the chapter on Fourier series only the first two sections are devoted to the statement, without proof, of Fourier's expansion theorem and to the explanation of the method of finding the Fourier coefficients. There follow seven physical applications taken from the theories of the flow of heat, of the vibrating string and of the flow of electricity. An extensive bibliography is given at the end of the book. It is composed largely of titles of books and treatises which the student may read if he wishes to pursue a given subject further.

In the opinion of the present reviewer the value of this book would have been enhanced if more theorems had been stated. While the author is careful to make accurate statements, his results are not usually collected in theorem form. Such a collection of results would have made the book more suitable for reference. Another useful purpose of the theorem is that it brings into sharper relief the distinction between those results which have been proved and those whose demonstrations have been omitted or merely outlined. In his introduction the author himself stresses the importance both for teacher and student of distinguishing between proof and heuristic discussion. Here would have been an additional way of accentuating the difference. No text can include enough subjects to satisfy the whims of every instructor. Yet the reviewer feels that there has been one serious omission in the book under review—the Stiltjes integral. True, this subject has seldom been included in an advanced calculus. But this integral has recently become such a practical tool for the analyst that it is becoming of universal use. Unfortunately it is not yet widely known to physicists and to engineers. It could be of particular effectiveness in applied mathematics.

In conclusion it might be well to summarize what seems to be the chief usefulness of the book. First it is an outstanding text for courses in applied mathematics for engineering students and for science students. It should also prove very serviceable to the practicing engineer who wishes to refresh or improve his mathematical knowledge. The book may also be used for courses given by mathematics departments, especially for "service" courses designed to provide non-mathematics concentrators with mathematical tools. For the pure mathematician, the book would have less value as a text, precisely because it does not emphasize the logical development of the subject.

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THE NEEDS OF MAN

Enough and to Spare. By KIRTLEY F. MATHER. Pp. 186, New York: Harper and Brothers, 1944. $2.00.

THE aim of this little book is to show that it is not

the niggardliness of nature but the stupidity of man which imposes the sufferings of poverty and war upon such a large proportion of mankind. Perhaps Dr. Mather would object to such a statement of his aim and would prefer to say that he is trying to show that man's economic suffering is not inevitable but is due to his failure to make use of his scientific knowledge to increase production, to improve the distribution of what he can produce and to control his population growth.

In order to establish his thesis Dr. Mather examines the adequacy (a) of land and minerals for man's probable future needs, and (b) argues that his future needs should not be calculated on the assumption of an indefinite increase in numbers, but rather on the assumption that even the "backward" peoples will shortly come to control their population growth as Western Europeans are now doing.

As regards the first of these points Dr. Mather seems to imply that if he can show an adequacy of resources in the world for the population of the world as a whole there is no need to worry about population pressures disturbing the peace and welfare of mankind. True, he urges a reorganization of world economy and in his later chapters argues eloquently and convincingly for adequate international organization to relieve the needs of growing population in the unindustrialized areas of the earth, but he does not seem to the reviewer to appreciate the fact that these unindustrialized peoples will grow even more rapidly for several decades after they begin to industrialize than they have in the past and that there is as yet no evidence of any intent on the part of the powers possessing unused land and resources to allow these "backward" peoples to share them. It is out of the differential growth of peoples and the differences in their resources that those pressures and frustrations arise which can be played upon by demagogues as excuse for conquest. They will continue to be so used as long as they exist and the crushing of Germany, Japan and Italy will not stop their being exploited. There may be even more violent conflicts when India and China reach Japan's stage of development and find their access to unused resources blocked by the "haves." We should realize that it is not *absolute* poverty which leads a people to seek the expansion of their resources by force but *felt* poverty. The fact is that once a people begins to enjoy a little better living conditions the *feeling* of pressure on resources, both agricultural and mineral, may grow rapidly; that as *actual* pressure begins to lessen *felt* pressure quite commonly begins to grow, especially if resources are scanty. Witness Japan and Italy!

But even if Dr. Mather is right in arguing that there is "enough and to spare" it seems to the reviewer that he ignores too blithely the practical difficulties standing in the way of increasing the agricultural product (food supply) in most countries and the slow and painful progress of industry in poverty-stricken lands which also have meager natural resources. He also seems to discount unduly the increased work involved in making use of inferior grades of mineral resources. If Dr. Mather had ever tried to make two bushels of wheat grow where one grew before or to get his cows to give six gallons of milk instead of three he would be less optimistic than he is about increasing the world's food supply; he would not accept so uncritically the statements of chemists and plant breeders that *manifold* increases of agricultural products are readily attainable. Likewise the reviewer doubts he would believe in the possibility of expanding the tilled area of the earth to about three times its present size if he had gone out to observe the use of land in the highways and byways of the earth with as adequate an agricultural background as he has in geology. It seems highly doubtful that India or China will have "enough and to spare" of food for a number of decades. Furthermore, the use of leaner iron ore, of shale for oil, of thinner and deeper seams of coal, of more distant and more fractious sources of water power will require more labor, or with better processes as much labor as those we are now using. It is not helpful to gloss over these practical economic difficulties in getting "enough," to say nothing of the "to spare."

But even so Dr. Mather is probably right in believing that the economic and technical difficulties as such are not insurmountable. But for all his eloquent argument for world organization he does not seem to appreciate how futile technological skills and scientific knowledge are if political and social conditions do not give them a chance to work.

Finally, as a student of population, the reviewer can not accept the view that because Malthusianism is not forever inevitable it is, therefore, of no importance in the affairs of man at given times and places. The fact is that for perhaps two thirds of mankind even now the only factors preventing more rapid growth of numbers are disease and hunger and war, and that for perhaps one half or more this will continue to be the case for several decades, perhaps for a century. Among Oriental peoples only the Japanese have yet shown any decline in the birth rate. Almost one billion people in south and east Asia still grow about as rapidly as their "subsistence" (Malthus) increases. Moreover, among them the control of disease is just beginning and death rates are two to three times as high as in the western World. To these southern and

eastern Asiatics whose growth is still Malthusian in character must be added most of the population of the Near East, of Africa and of a considerable proportion of Central and South America. Merely as an illustration of what is happening it may be noted that the Indians increased by about 83 million in the 20 years following 1921—from 306 million to 389 million.

Dr. Mather seems to think that these "backward" peoples will not long continue to grow as fast as their "subsistence" increases and therefore, will not feel any increased pressure on their food supply or on their economy as a whole. The reviewer can not agree with this view. He believes they are feeling increased pressure already in many places and will feel much more as their conditions begin to improve. He believes that the political and economic life of the world is not organized to take care of an increase of 50 to 75 million in India in each decade between now and the end of the century. Only increased pressure on subsistence which will raise the current high death rate to about the level of the birth rate will prevent this, for there is no one fairly familiar with India's population who believes there will be any significant decline in her birth rate within five to six decades. Furthermore, even after the birth rate begins to decline the death rate will decline even faster for two to three decades thus raising the rate of growth. If the entire population of south and east Asia (excepting Japan) were to increase as rapidly as that of India (1931–1941) it would grow by at least 140 million in 1940–50 (this is more than the entire population of the United States) and would increase even more rapidly thereafter. Is there any reasonable hope that China and India can care for 80 to 85 per cent. of such an increase within their own borders for the next half or three quarters of a century? The reviewer believes the answer must be, no! Then we must ask if there is any hope of political reorganization which will give these countries access to the land and minerals of which Dr. Mather says there are "enough and to spare." The reader will give his own answer.

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SPECIAL ARTICLES

INTERACTION BETWEEN CRYSTALLINE PENICILLIN AND HUMAN PLASMA PROTEINS[1]

PLASMA proteins which were formerly conceived to be only inert colloids, having to do with fluid equilibrium, are now known to be able to bind with small molecules of physiological importance. Schonholzer[2] concluded from his electrophoretic experiments that there is a union of azo-dyes of sulfanilamide with serum albumin. Davis[3,4] showed binding of sulfonamides with serum albumin by equilibrating the drugs between a plasma protein solution and a buffer solution. On the other hand, Kimmig and Weselmann[4] showed, by the technique of cataphoresis, that sulfonamides are "adsorbed" to serum albumin and that dissociation can be produced by animal charcoal. The ability of plasma protein to combine with phenol red[5,6,7] has also been demonstrated by the spectrophotometric absorption method.

Since penicillin is now widely used clinically, it is of extreme interest and importance to ascertain whether it will combine with human plasma protein. For that purpose, we have used as test proteins electrophoretically homogeneous γ-globulin and albumin, as well as a mixture of α- and β-globulins, at the concentration present in normal human plasma. Thus 7 ml of a protein solution, pH 7.8, containing 125 micrograms of crystalline sodium salt of penicillin per ml were put into a Cellophane bag and equilibrated with 14 ml of a phosphate buffer solution of penicillin of the same concentration and the same pH. After 18 to 24 hours of continuous rocking at 1° C. the concentrations of penicillin, in plasma and in buffer, were determined. It was found that, if albumin is used, the antibiotic activity of the protein solution after equilibration is greater than that of the dialysate (see table 1). Moreover, the greater part of

TABLE 1

THE ANTIBIOTIC ACTIVITY OF EXTERNAL AND INTERNAL FLUIDS, BEFORE AND AFTER DIALYSIS, IN OXFORD UNITS PER ML*

		External fluid (Penicillin in buffer)	Internal fluid (Penicillin and albumin in buffer)
Experiment I	Before dialysis	187	187
	After dialysis	151	284
Experiment II	Before dialysis	178	187
	After dialysis	150	246

* 1.0 mg of the crystalline sodium salt of penicillin = 1,650 Oxford Units.

[1] From the Laboratory of Physical Chemistry and the Division of Microbiology, The Squibb Institute for Medical Research, New Brunswick, N. J.

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[3] B. D. Davis, SCIENCE, 95: 78, 1942.

[4] B. D. Davis, *Jour. Clin. Investigation*, 22: 753, 1943.

[5] J. Kimmig and H. Weselmann, *Dermat. u. Syph.*, 182: 436, 1941.

[6] A. Grollman, *Jour. Biol. Chem.*, 64: 141, 1925.

[7] H. W. Robinson and C. G. Hogden, *Jour. Biol. Chem.*, 137: 239, 1941.