the floristic regions of North America, as well as a conception of the characteristic associations and successions. Structural adaptations to the factors of the environment are not neglected, and such time-honored topics as saprophytism, parasitism and symbiosis are given due consideration.

Indicative of the modern trend to consider biological science from some of its broader aspects—from without as well as from within—are three chapters, one on "The Principles of Evolution," one on "The Causes of Evolution" and one on "Plant Life of the Past." These cut across the subject-matter of various fields and leave the reader with an inkling, at least, of the magnitude of the organic world.

Some will wish, perhaps, that the author had entrusted to his students more of the choice bits of the results of modern research, even though such findings may not be destined for eternity; but that is largely a matter of individual preference, and this book, intended primarily for a one-semester course, is necessarily limited in length.

The illustrations are superior—clear and convincing, artistically prepared and largely original.

The author aims "to introduce the college student to the science of plant life"; this he does, admirably.

General and Economic Botany. By ERNEST ELWOOD STANFORD. xxix + 675 pp. 436 figs. New York and London: D. Appleton-Century Company. 1937. $4.00.

SINCE the subject-matter of botanical science continually increases, the text-book extract prepared for student consumption tends to become more and more concentrated. There is a feeling of luxury, therefore, in opening a volume like this, that exceeds somewhat the usual limitations on length and that offers the reader a glimpse of some of the more interesting and humanly important features of this field of endeavor.

"General and Economic Botany" covers the subject-matter included in the standard texts somewhat more fully than usual. There are chapters on cells and tissues, the morphology of leaves, stems, roots and flowers; the functions of these parts of the plant are largely woven into these same chapters, although fifty-seven pages are set aside for "The Seed Plant and Its Environment."

The plant kingdom is divided into the Thallophyta and the Embryophyta, the former being subdivided into the Schizophyta, Phycophyta and Mycophyta, while the latter includes the Bryophyta, Pteridophyta and Spermatophyta.

The seed plants are obviously the author's forte, as might be expected in a book placing emphasis on the economic aspects of the subject. One hundred and forty-four pages are devoted to the groups of the Angiosperms alone. Our more common and important orders and families are considered carefully, along with a considerable number of those more characteristic of the tropics.

Within the covers of this volume information is assembled on a wide variety of botanical topics. Most of our other general texts, for example, contain little or nothing on such items as glutathione, phyllodia, kapok, marihuana, dulse, rainfall and erosion areas of the United States and countless other subjects here included.

The broad basis on which this work is fashioned is reflected also in the 436 illustrations, not a few of which are original, though many have been culled from a wide variety of sources. The lack of uniformity in the figures is more than offset by their diversity of origin and by the scope of the subjects that they portray.

Specialists in particular fields will undoubtedly find shortcomings and inaccuracies. They are almost inevitable in a book of this breadth prepared by one man. From its very scope it lacks the unity of a more compact treatise—it suggests the banyan tree rather than the Colorado blue spruce.

The author writes that his aim is "to introduce the student to one great area of the biological world as a larger place to live in, rather than to train botanists to join an overcrowded profession." If those who study this book are willing to contribute some leisure and some meditation, he will succeed, and they will profit.

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SPECIAL ARTICLES

ADSORPTION OF ANTIBODIES BY EGG ALBUMIN FILMS

THE possibility of demonstrating immunological reactions with films on a water surface, or those transferred on to metal plates by the Langmuir technique has been dealt with in several recent papers.[1] We have carried out experiments with solutions of crystallized hen egg albumin and anti-egg albumin rabbit sera. Films were deposited under a pressure of 12 dynes/cm on chromium-plated slides covered with 37 to 51 layers of barium stearate. Increments of thickness were followed optically as described by Blodgett and Langmuir.[2] Polarized sodium light was used as source of illumination and the value 1.495 was assumed for the index of refraction of the proteins. When a 1 per

[1] *Cf.* E. F. Porter and A. M. Pappenheimer, *Jour. Exp. Med.*, 69: 755, 1939; M. F. Shaffer and T. H. Dingle, *Proc. Soc. Exp. Biol. and Med.*, 38: 528, 1938.

[2] K. B. Blodgett and J. Langmuir, *Phys. Rev.*, 51: 964, 1937.

cent. solution of ovalbumin was applied to two monolayers of immune serum (thickness of double layer 25A) there was an increase in thickness of about 35A, but the same increase was seen with normal rabbit serum. Experiments were also made with plates coated with monolayers of sera on which monolayers of ovalbumin were deposited, or *vice versa*. Here likewise no difference was found in the behavior of immune and normal sera. On the other hand, when the slides were first coated with one or two layers of spread

TABLE 1

Number of layers of ovalbumin	Total thickness ovalbumin	Serum applied	Increase in thickness
	(A)		(A)
2	20	Anti-ovalbumin, No. 1	50
2	18	" " No. 2	58
2	19	" " " "	49
1 (down) ..		" " " "	50
2	16	" " No. 3	41
2	16	" " " "	41
2	14	" " No. 4	40
2	18	" " " "	55
1 (down) ..	9	" " " "	45
1 (down) ..	9	" " " "	46
2	17	" horse serum No. 1	5
2	19	" " " "	7
2	21	" " " No. 2	5
2	15	" chicken serum	14
2	16	" " "	14
2	22	" Pneumococcus I	7
2	15	" " "	7
2	17	" guinea pig red cells	6
2	18	" " " "	12
2	15	" horse red cells	15
2	10	" " "	15
2	22	normal No. 1	4
2	16	" "	7
2	20	" No. 2	2
2	21	" No. 3	—
2	17	" No. 4	7

ovalbumin and then (undiluted) immune serum applied to the plate for 3 minutes, a specific effect was observed (see Table 1) as in the work of Porter and Pappenheimer with pneumococcus polysaccharide. In the experiments summarized in Table 1, made with various immune and normal rabbit sera, an interval of 20 minutes was observed between initial spreading and transfer of the film, in order to allow time for unfolding. The increase in thickness following the application of an immune serum was the same whether there were two layers or one layer of egg albumin. The differences between the adsorbed layers of various heterologous antisera call for further investigation.

It would appear therefore that thin films (9 A) of protein are still capable of reacting with antibodies while, as has been reported by Danielli, Danielli and Marrack,[3] the reactivity of antibodies is destroyed by unfolding of the molecule. The experiments of these authors, unlike ours, were made with purified antibody and are free from the objection, prevailing in the case of whole antiserum, that the films may contain too small a proportion of antibody.

[3] J. F. Danielli, M. Danielli and J. R. Marrack, *Brit. Jour. Exp. Path.*, 19: 393, 1938.

The available observations on antibody films and inactivation of antibodies by denaturing agents lend support to the view that the specific reactivity of antibodies is to a large extent dependent upon structures different from those which mainly determine the specificity of antigens.[4, 5]. In this connection reference ought to be made to the theory of Mirsky and Pauling[6] on the structure of proteins, according to which proteins owe characteristic specific properties to the folding of the polypeptide chain "into a uniquely defined configuration . . . held by hydrogen bonds. . . ." Pointing in the same direction as the above evidence is the puzzling fact that an unlimited number of different antibodies can be produced, all having the same chemical characteristics of serum globulins; one idea to be considered among others is the possibility of different ways of folding of the same polypeptide chain.

In experiments made with plant haemagglutinins (*cf.* 7), it was seen that monolayers of bean agglutinin (phasin) of a thickness of 9 A, or double layers dipped for a short time in a suspension of washed horse blood, became covered with red cells in a homogeneous single layer which was not removed by repeated rinsing with saline solution. The agglutinin used was a purified preparation showing only a single boundary when examined by the method of Tiselius.[7] A similar result was obtained with a partially purified agglutinin of castor beans, swine blood being used. For reasons not yet known this conspicuous reaction was not regular, the coating with blood cells being often sparse or spotty. If the plant agglutinins actually are relative in the unfolded state, in apparent contrast to antibodies, this might be connected with the low specificity of these reactions.[8] However, no definite conclusions can as yet be drawn from these observations, particularly in view of the possibility of errors in the interpretation of this sort of experiments, recently emphasized by Langmuir and Schaefer.[9] After this communication had been completed there appeared a paper by L. A. Chambers[10] concerning films of a nucleoprotein antigen.

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[4] K. Landsteiner and J. van der Scheer, *Jour. Exp. Med.*, 67: 709, 1938.

[5] J. R. Marrack, IV Congresso Internazionale, Rome, 1939, Vol. I, p. 347.

[6] A. E. Mirsky and L. Pauling, *Proc. Nat. Acad. of Sciences*, 22: 439, 1936.

[7] L. G. Longsworth and D. A. MacInnes, *Chem. Rev.*, 24: 282, 1939.

[8] K. Landsteiner, "The Specificity of Serological Reactions," 1936, Chas. C Thomas, Springfield, Ill.

[9] J. Langmuir and V. J. Schaefer, *Chem. Rev.*, 24: 199, 1939.

[10] L. A. Chambers, *Jour. Immunology*, 36: 543, 1939.