ive use. This, the report says, is equally true of the weapons of industry. The brains, even the very processes, that to-day are necessary to the output of munitions were yesterday needed, and will be needed again to-morrow, for the arts of peace. The council was faced from the first with the fact that the war had greatly reduced the number of workers available for research, and it found that certain researches conducted or directed by professional associations in the period preceding the war stood in grave jeopardy of enforced abandonment. The first act of the council, therefore, was to save as many derelict researches as possible; its second was to confer with professional and other societies concerned, especially with chemical and electrical industries; its third to form a register of researches; its fourth to aid research in educational institutions, and its fifth to form the standing committees already mentioned. The appointment of other standing committees is in contemplation. The sphere of universities and technical colleges in relation to the work with which the council is concerned is discussed, and finally certain general conclusions are drawn. The first is that a largely increased supply of competent researches must be found, and the second, that there must be a hearty spirit of cooperation among all concerned, men of science and of business, working men, professional and scientific societies, universities and technical colleges, local authorities, and government departments. It was found that the output of the universities before the war was altogether insufficient to meet even a moderate expansion in the demand for research. It is hinted that hitherto the scientific army in Great Britain has consisted of a brilliant group of staff officers, and it is bluntly said that we have not yet learnt how to make the most of mediocre ability, though without scientific rank and file it will be as impossible to staff the industrial research laboratories that are coming as to fight a European war with seven divisions. The council expects to be able to encourage a longer period of training by the offer of research studentships, but "it is useless to offer scholarships if competent candidates are not forthcoming, and they cannot be forthcoming in sufficient numbers until a larger number of well-educated students enter the universities. That is the problem which the education departments have to solve, and on the solution of which the success of the present movement in our opinion largely depends." The council considers that the organization of research in the interest of various industries must be coordinate. "It must be continuous in its operation, and its ramifications will spread as knowledge grows. It will inevitably tend to bring industries into intimate relation which are at present independent of each other; to transform what have hitherto been crafts into scientific industries; and to require cooperation, not only between different firms in the same industry, but between groups of industries in a continuously widening series of interrelated trades. The forces which are at work in this direction have elsewhere found their expression in connection with the trust and the combine; but we believe, if the real nature of these forces is clearly grasped, that it will be possible to organize them for the benefit, not only of the industries, but of the nation as a whole."—*The British Medical Journal.*

SCIENTIFIC BOOKS

Annals of the Dearborn Observatory, Northwestern University. Volume I., Historical and Descriptive Introduction, Measures of Double Stars. By PHILIP FOX, director of the observatory. Published at Evanston, Illinois, 1915. 4to. Pp. 229.

Science often moves along paths that soon become obscure to the eye of the historian. He can always trace the course of the highways, marked as they are by published contributions. But he may easily miss the almost equally important though less conspicuous byways through the quiet places—the influence of a great teacher, or the silent force of an example of devotion. He who seeks to account for the great activity in America along the lines of observational astronomy must not overlook or underestimate the part that Burn-

ham has played in this movement. He has planted in two of our great observatories a tradition of faithful observing that will long endure; and from these two institutions the same tradition has been transplanted to smaller and to newer observatories. We are reminded of this by Professor Fox's dedication of this first volume of annals from the Dearborn Observatory: "to Sherburne Wesley Burnham, who spared not himself in his oft heroic vigils, whose personal encouragement has been the direct inspiration for these observations." These words might have been as fittingly written by many another astronomer.

Only a few of the world's great telescopes are used to their full capacity, and most of these few are to be found on this side of the Atlantic. Among them must now be counted the Dearborn telescope, which has been used whenever the sky has permitted on almost every night since the fall of 1909, a date that marks the advent of the present director. This is a remarkable record, for during most of this time Professor Fox has worked single handed, and at no time has he had more than one assistant. Moreover, in addition to his work at the telescope he has fulfilled various administrative duties and has taught classes at the Northwestern University. It is clear that the Dearborn telescope, though it is a beautiful and efficient instrument, is not at present the chief asset of the Dearborn Observatory.

The introduction to this volume contains an historical account of the observatory, beginning with the formation of the Chicago Astronomical Society in 1862, the purchase immediately afterward of the 18½-inch telescope, the early struggle for existence, the almost fatal blow dealt by the great fire of 1871, and finally the happy affiliation in 1887 with the Northwestern University. The telescope was for a time not only the largest in the world but probably also the finest. Its excellent qualities have been proven by the discovery of the companion to Sirius (while still in the hands of its makers, Alvin Clark and Sons); by a long list of measures of difficult objects by Burnham, Hough and Fox; by the excellent photographs that have recently been made with it; and most convincingly of all, by the results of an application to it of the Hartmann tests. Professor Fox carried out these tests in 1912 and 1913 and describes them fully here. They show that when the objective is at its best there is practically no spherical aberration. They also indicate that under certain temperature conditions a considerable amount of aberration may be temporarily present, the effect being similar to the phenomena that the reviewer showed to exist in the case of the Thaw telescope at Allegheny and in one or two other very large refractors. This effect is correlated, not directly with the actual temperature, but rather with the rapidity with which the temperature has changed in the interval immediately preceding the making of the test.

Two chief investigations are now being carried out with this telescope, the determination of stellar parallaxes by photography, and the systematic measurement of double stars. It is to the latter that the present volume is devoted. The random discovery of new double stars or the casual measurement of the best known doubles, does not add much to the progress of this branch of astronomy. Professor Fox has wisely adopted an observing program made up of definite lists of stars that would not be likely to receive attention otherwise. The volume before us is chiefly concerned with the double stars discovered by Holden, with those discovered by Küstner, and with a selected list from Burnham's General Catalog. Much care was expended on the arrangement and printing of the observations, so that the volume is not only a beautiful example of the printer's art, but is one that leaves nothing to be desired on the score of convenience of reference.

Some of the pairs in this volume were measured not only with the Dearborn telescope, but earlier also with one or both of the Yerkes refractors of 12 and 40 inches aperture, respectively. The comparison of the measures of the same object made by the same observer is very instructive. The reviewer has collected all such cases in the volume and has arranged

them in the order of the angular separation of the two components. We thus get the following means, the number in parentheses indicating how many pairs are included in each mean:

MEASURED SEPARATIONS

With the 12-Inch	With the 18½-Inch	
"	"	
0.94	1.14	(5)
1.80	1.96	(5)
2.34	2.43	(5)
3.29	3.32	(5)
4.18	4.25	(5)
With the 12-Inch	**With the 40-Inch**	
"	"	
0.68	0.85	(5)
1.13	1.34	(6)
1.71	1.87	(4)
2.05	2.22	(6)
2.55	2.57	(5)
3.96	4.03	(8)
4.65	4.66	(6)
With the 18½-Inch	**With the 40-Inch**	
"	"	
0.83	0.88	(5)
1.54	1.59	(6)
1.98	1.93	(6)
2.45	2.50	(6)
3.54	3.55	(6)
4.34	4.29	(7)

Measures made with the two large telescopes show little or no systematic difference, but those made with the 12-inch yield smaller separations than either of the others, the difference being largest for small separations and becoming negligibly small for separations in the neighborhood of 5".

In the recently issued Volume 12 of the Publications of the Lick Observatory, Professor Aitken gives a long list of measures of double stars. Many of these were examined with both the 12-inch and the 36-inch telescopes of that observatory, so that we have an opportunity for making the same kind of tests as on Professor Fox's observations. The results similarly collected are as follows:

MEASURED SEPARATIONS

With the 12-Inch	With the 36-Inch	
"	"	
0.52	0.42	(20)
0.62	0.54	(25)
0.71	0.64	(20)
0.81	0.79	(24)
1.07	1.03	(24)
1.38	1.39	(21)
2.13	2.10	(26)
4.49	4.53	(18)

Here again we have a systematic difference that increases as the separation becomes smaller. But in Professor Aitken's measures the difference has the opposite sign from Professor Fox's, the measures with the smaller telescope coming out larger than with the greater telescope. It would be interesting to know whether these are instrumental peculiarities or whether they have their origin in the habits of the observers. In any case it seems likely that a discussion of the systematic errors of telescopes and observers would be well repaid in the additional accuracy with which double-star orbits could be computed after the application of systematic corrections. Some attempts at such a study have been made, but (so far as the reviewer is aware) none of them is as thorough as the importance of this matter warrants. Needless to say that the presence of systematic errors of this kind is evidence for the skill and the care of the observer rather than against. In the work of an inexperienced or careless observer, such small effects as these would be buried under an accumulation of accidental errors.

FRANK SCHLESINGER
ALLEGHENY OBSERVATORY OF THE UNIVERSITY OF PITTSBURGH,
September 30, 1916

The Sessile Barnacles (Cirripedia) contained in the Collections of the U. S. National Museum; including a Monograph of the American Species. By H. A. PILSBRY. Bulletin 93, U. S. National Museum, 1916.

In this great work, of 366 pages with 76 plates, Dr. Pilsbry brings the American sessile barnacles out of obscurity, and furnishes the means whereby all who will may continue the investigation of the group with as much ease as the nature of the subject permits. A critical review of the book could only be written by one who had covered at least a considerable part of the field by his investigations, and at present Dr. Pilsbry stands alone in this country in his knowledge of barnacles, with no