confidence of those who are alive to the importance of saving our Nature reserves before it is too late. The task of protecting such properties from the dangers which threaten them is not an easy one, even after they have been acquired, as was hinted in the account of Scolt Head given in our columns on Thursday. But the first step is their purchase, and it is satisfactory that that step has again been successfully taken and another home of wild life added to the secured treasures of the nation.

Few societies have gone more steadily forward, even during the last nine difficult years, than the National Trust. It is not yet thirty years old, but in a very short time it won such public confidence that it received special powers under its own Act of Parliament; and it has now more than a hundred properties of one kind or another. What is more remarkable is that nearly half of them have been acquired during the lean years which have followed 1913. Of course a hundred is a mere drop in the ocean of "places of natural beauty or historic interest" which it would be desirable to see in the hands of the Trust. But it is a beginning, and a beginning which has grown fast, and promises to grow still faster. The truth is that the growth of the Trust is partly the result and partly the cause of a change in public opinion. A hundred, and even fifty, years ago buildings of the greatest historic or architectural interest were destroyed, places of exceptional beauty were built over or otherwise ruined, and scarcely a voice was heard in protest. Such crimes, or follies, are still committed, though much less often; but now they never fail to arouse public indignation. The whole movement demanding the preservation of great architecture and the protection of beautiful landscape has gathered greatly increased force since the foundation of the Trust. The original Ancient Monuments Act has been largely extended: a permanent Commission on Historical Monuments has been appointed, and has already published its survey of several counties; a Society for Nature Reserves has been founded; many dioceses have established committees for the care of their churches; and the National Trust itself has become the owner of one or two large and many small historic houses, several properties having associations with such great names as those of Gray and Wolfe and Coleridge, and some thousands of acres of the most beautiful open land in the country, including a large part of the shore of Derwentwater and other properties adjoining Ullswater and Windermere. Such achievements are proof of the strength of the movement and a sure promise of its future development. *Vires acquirit eundo.* What is done to-day will be doubled to-morrow. But the need is doubling, too. Time and man are always engaged in the work of destruction, and an always increasing population is always needing more open spaces. However fast the Trust grows, it is certain that it will not, at least in our time, overtake the calls made upon it.—*The London Times.*

SCIENTIFIC BOOKS

A History of Magic and Experimental Science during the First Thirteen Centuries of our Era. By LYNN THORNDIKE, Ph.D., professor of history in Western Reserve University. Two volumes, I. xl. 835, II. vi. 1036. New York, The Macmillan Company. 1923.

PROFESSOR THORNDIKE'S book of two volumes and more than 1800 pages will easily take the lead of all that has been said of the intellectual conditions of the period of which it treats. It stretches across the centuries from the time of Pliny and Galen to the time of Dante. This is a period of depression in the history of thought in its various phases, of which several writers in this country have studied the details in notable works. To those few still active who in their younger days may have entered the subject through the fascinating pages of Draper's "Intellectual Development of Europe" and are still attracted by the subject, this product of Thorndike's labor will be especially of interest as exhibiting the steps forward in scholarship and in the energy and enterprise of research which it exhibits. The work of Lea on the activity of the "Inquisition in the Middle Ages" and the more recent one of Taylor on the "Medieval Mind" are treasure houses, somewhat dreary, it must be confessed, for the future student, but this book of Thorndike's, for fullness and completeness of reference, for excellence in presentation, for thoroughness of scholarship, leads them all. The reviewer is not familiar with any recent works in this field in foreign languages which can be compared with it. The preface reveals in outline the vast labor undergone, as intimated by the author, and the diligent reader on finishing it will find the author has not exaggerated it, indeed his modesty has not done justice to it in his own account.

In a subject so dull, even so repellent to many readers, he has labored to relieve the tedium of perusal by many touches of humor, but there might well have been more of them, for the record is a long and tiresome one—a record of the imbecility of the human mind at its worst since it has found a method of perpetuating its workings in cursive script. An essay on some aspect of the subject of magic may be made attractive by picking out the high points which allure, but to write an exhaustive and at the same time an attractive compendium of it is another matter. To combine with it an exposition of the springs of what we call experimental science makes it a task

calling for the strength of a Hercules and the omniscience of Jove. In fact the history of experimental science in this connection does not stand forth as it should if Dr. Thorndike were a demigod. In the matter of the exposition of medieval magic the book leaves little to be desired, but for the exposition of the sources of experimental science one must look elsewhere in some future compendium that goes far back of Galen. Such a work should expose more fully the experimental side of Galen's activities. His work on the arteries, but for the impediment of his theories, should have led to a very much better comprehension of the circulation of the blood long before Harvey. His experiments on the spinal nerves and the utilization of the vivisection of apes for the purpose might well have crowded out of Dr. Thorndike's book some of Pliny's drivel. In beginning magic with Pliny the author does not perhaps go far wrong, but experimental science does not begin with Galen nor with the school at Alexandria either, for that matter. Pliny's primitive magic, it is true, was probably already old in the world, and in written history there seems little to cavil at if a start is made with his Natural History, but not so as to experimental science beginning with Galen. This the author very explicitly admits and pleads very justifiably the law of limitations. Nevertheless, one must beware of thinking of magic and experimental science with its start at Pliny and Galen as one involuntarily does in this exposition of them.

It is natural to find Professor Thorndike in difficulties with definitions. "Let a woman spit three times in a frog's mouth and she will not conceive for a year," or, to choose again, this time an example of a technique difficult or impossible to perform, which is a notorious trick with magicians, Saint Hildegarde said, to get a really serviceable amulet you must catch a poisonous snake after he has skinned himself in a cleft of the rock and dry him for the purpose. There is no difficulty in defining these things as magic, but when we come to astronomy arising out of the hokus-pokus of astrology, a thing which the author seems unduly to deprecate, or of chemistry out of the supercheries of alchemy, we are on different ground and do not know which to call these activities of medieval monks, magic or experimental science. Now we don't have that trouble when we read Hippocrates or Aristotle; we have to go back to Empedocles for that. With him he must have begun if he was to justify his title as to experimental science. He must have led us up the crest of the wave to the pinnacle of the glory of Greece and down again to the trough of the sea with Pliny and Sextus Empiricus, but even back of them lies a magic, Babylon and Egypt and the Zend Avesta and the Rig Veda and the Poem of Gilgamesh. Now Professor Thorndike realizes all this and there can be no criticism for his curtailment of the subject, but he should have left "experimental science" out of his title if he was going to begin with Galen and give us so little of it even with him.

There are certain defects perhaps unavoidable in thus breaking arbitrarily into the full current of the evolution of thought in the domain of magic and science, admitted though the necessity must be for curtailment. The man-eating ants who mined gold for Prester John and the emetic recommended once a week in the Secret of Secrets of the Pseudo-Aristotle, Hildegarde's boiling of swamp water for drinking purpose, as Cyrus did for the waters of the Choaspes, might all have been found in Herodotus. Even the mistake about respiration of goats through their ears is found in the fragments of Alcmaeon long before Herodotus. Spitting magic came straight out of Egyptian papyri from the primitive magic back of them. The magic of numbers goes back of Pythagoras and is found in far lands which knew naught of any intellectual matters in medieval Europe. Belief in the gods did not antedate magic, but that is a matter of definition again into which we can not go. The Virgil of our modern editions of the Georgics II says nothing at line 480 of gems or herbs or of the minds and wrath of brutes, of fruits or reptiles. Hugh of St. Victor gives quite another hue to the color of line 479 by finding them in his edition, quite a magical atmosphere, which in reality Virgil did not breathe so copiously as the middle ages would make us believe. Comment on this is unfortunately lacking in Professor Thorndike's account. Perhaps he hardly meant to attribute to Galen Alcmaeon's theory of the wave nature of sound, but so the reviewer reads it in the text. The story of Galen catching the lady in love with a play actor is the exact counterpart of a story attributed to Hippocrates in the malady of Prince Perdiccas and more plausibly the same story was told of Erasistratus, because in his time all Alexandria was agog with interest over Herophilus and his work on the pulse. If he had started at the beginning of experimental science with the Greek philosophers, for instance, we would have found the author experimenting in a spurious book of the Hippocratic Corpus with the question of drink passing into the lungs and making a mistake as even scientific experimentalists will do occasionally. As to various other matters relating to the theories of elementary cognition the author might have found a summary in the excellent work of Beare on the subject dealing with work of the predecessors of Aristotle. Whatever Hero of Alexandria may have done in his day, the phenomenon of air pressure on a column of water was adequately demonstrated by Empedocles with his clepsydra. It was primarily on these Adelard of Bath must have based his elaborations. It is interesting,

however, to see the mind of Peter of Abano filled with a hopeless longing for a knowledge of the atomic weights of the elements, but it is not stated if he was guided thereto by Archimedes' celebrated discovery of specific gravity.

Roger Bacon fares badly at the author's hands, one is afraid, because we all in the last twenty years or so have been fed up on Bacon (no pun intended). The guides in Rome irritated the Innocents Abroad by all but ascribing the creation of the world to Michael Angelo, and we have grown a little sensitive about Roger Bacon being wholly responsible for the creation of experimental science, and Professor Thorndike stands so straight on the subject he seems to the dispassionate reader to lean over backwards a little For any one who has wrestled spiritually as well as physically with the tomes of Albertus Magnus, who seems to be his hero, it would be easy to make the Swabian leviathan somewhat of the same kind of a bore. One is, as it is, tempted to say he owes his fame to longevity and industry

There is a tendency to the repetition of certain phrases, which jars the attentive reader a little, there are some words used which are not to be found in the Century dictionary, some slips, but very few, in proof-reading. Indeed, such minor blemishes are exceptionally scarce for a work so extensive. Some perhaps not so negligible may nevertheless be passed over. It is hardly justifiable to refer further to these comparatively few shortcomings, since there is not more space permitted for an appreciation of the merits of a book which is, on the whole, an ornament to American scholarship.

JONATHAN WRIGHT

SPECIAL ARTICLES

ON THE ADAPTATION OF WHEAT TO GROWTH MEDIA DEFICIENT IN NUTRIENTS

IN the correlation obtained between differences in yield of grain of different varieties of spring wheats and that of their relative earliness of maturation appears a relation that suggests a factor which presumably plays no inconsiderable rôle in the adaptation of variety of wheat (and probably other plants) for maximum grain production from growth media markedly deficient in essential salt elements. Of nine different varieties grown in such a medium, the largest yield of grain, 200 milligrams per culture (average of 20, each containing 5 plants), was produced by the variety that ripened first, and the lowest yield, 46 milligrams per culture, produced by one of the last maturing varieties. The other varieties produced yields of grain that fell between these two limits, and the magnitude of yield generally corresponded with the relative earliness of the variety. Seven weeks elapsed between the time the earliest and latest varieties ripened. There was no correlation between the total dry weights of the different varieties and their comparative earliness. The average dry weight produced per culture was approximately 1.3 grams, regardless of variety.

The plants were grown in tap water, which as a growth medium can be defined as being markedly deficient in essential salt elements. Its osmotic value was equal to approximately 0.12 atmosphere osmotic pressure, with the ions Cl, So_4, Ca and Mg constituting the major portion of the solutes. The grain per culture was that which five plants produced, having available to them only those solutes contained in two quarts of tap water (two quart Mason jars were used as the culture containers) plus that which the seedlings 6–9 cm. high, germinated in tap water, contained when set in culture jars and one-half c.c. of .01 mol. solution of $FeSO_4$ per culture added at the beginning of the experiment. When the plants were six weeks old, from 300 to 500 c.c. of distilled water were added to each jar, this being the only change or addition made to the original two quarts of tap water.

As there was no correlation between differences in yield of grain of the different varieties and that of their relative earliness of maturation when they were grown in fertile soil, the question may be asked as to causes operative to bring about the results obtained when tap water was used as the growth medium. It appears that the tap water had no particular merit per se other than being a growth medium, deficient in nutrients, which enabled that variety of wheat that completed its growth cycle in the shortest period of time (that is, an early wheat) to utilize that small supply of salt elements most efficiently in the production of grain. Granted that the rate of utilization of nutrients for similar processes in these wheats was about the same, and that some of the nutrients were used in such a way during the vegetative growth period of the plants as to preclude their later utilization for the production of grain, then obviously the wheat which has a long-growing period, being a late variety, has less nutrients available for grain production than has an early variety. Whether a variety of wheat is early or late undoubtedly is largely determined by genetic and environmental factors, but the result of these factors—that is, whether the variety is early or late—in no small measure determines to what extent that minimum supply of salt elements in the growth medium can best be utilized for the production of grain.

W. F. GERICKE

LABORATORY OF PLANT NUTRITION,
UNIVERSITY OF CALIFORNIA