Life stand the men of this little world—the fully developed, the underdone, and the unbaked, in one struggling, seething mass. On the other side, and on a level but one step lower down, stands the vanguard of the long procession of "Lower" Animals, led by the chimpanzee, the orang and the gorilla. The natural bridge that *almost* spans the chasm lacks only the keystone of the arch. . . . .

The great Apes have traveled up the River of Life on the opposite side from Man, but they are only one lap behind him. Let us not deceive ourselves about that. Remember that truth is inexorable in its demands to be heard.

Into this book Dr. Hornaday has put much of his philosophy of life as well as the choicest of his observations on the behavior of wild animals in nature and in captivity. The moral purpose which impelled the writer to expression is the defense of dumb creatures. Our author takes special pains to humble man by dwelling on his shortcomings. The reader is told that, though endowed richly with mind and gifts of expression and therefore capable of noble achievement in service and self-development, man at his worst is the most bestial of animals and more brutal than the so-called brutes.

"The minds and manners of wild animals" will disappoint not a few scientific students of animal behavior because it is not an exact systematic and analytic description of animal experience and action. It will delight almost everyone else by its directness, sincerity and naturalness. For the tens of readers who may get next to nothing from the book because of the "experimentalist bias"—to which the reviewer must plead somewhat guilty—there will be thousands who gain useful knowledge, insight and a more intelligent appreciation of wild animals.

The book should be taken, in the opinion of the reviewer, as a notable contribution to natural history, not as a scientific treatise on comparative psychology. It contains a wealth of amusing, interesting, thrilling and enlightening incidents and personal observations, a somewhat biographical assemblage of reflections and conclusions and a unique thought-provoking collection of brief characterizations of animal intelligence and temperament. Such is the contribution to animal behavior and rights which Dr. Hornaday has made from his almost unexampled wealth of experience as zoologist, hunter and scientific director of zoological gardens. The information presented should be of very considerable practical value to all who have to do with wild animals.

It would be a profitless task to discuss in SCIENCE the scientific grounds of dissatisfaction with a book which is primarily an account of personal experiences with wild animals. Conspicuous among them are terminology, definition, canons of judgment, inferences and generalizations. Such matters every scientific reader will note, but will he nevertheless be able, as the layman almost certainly will, to enter into and profit by the author's lifetime of intimate contact with wild animals? Let us hope so.

More to the point than a recital of the content of this volume is the injunction, "Read it and thus enter into the author's knowledge, sympathetic appreciation and insights." Truth is great. The ways of observing it are as varied as human intellect and temperament. It were a pity to lose the value of the naturalistic in our praiseworthy attempts to exalt the experimental study of animal behavior and experience.

ROBERT M. YERKES

SPECIAL ARTICLES

PROOF OF THE POWER OF THE WHEAT PLANT TO FIX ATMOSPHERIC NITROGEN

IN a series of wheat cultures in solutions, we have recently proved conclusively that wheat plants, even in only six weeks of growth, can fix large quantities of nitrogen from the air. They possess this power whether nitrogen is supplied to the roots or not.

Seventeen years ago, Jamieson[1] made the startling announcement, based on experiments, that all green plants possess the power of fixing atmospheric nitrogen. He supplemented this announcement by another to the effect that

[1] *Report of Agr. Res. Assn.*, Aberdeen, 1905, *et seq.*

special organs exist on the young leaves of plants whose function it is to fix the air nitrogen and he called these organs "albumen generators." This supplement to Jamieson's first announcement and the somewhat loose statement of his proffered evidence on the nitrogen fixation, coupled with the indelible impression of Lawes and Gilbert's and Boussignault's experiments and conclusions, caused the scientific world as a whole to scout or ignore Jamieson's evidence and the earlier contentions of Ville and a few others to the same effect. In 1911, Mameli and Pollacci[2] published a statement of experimental results which were not subject to the criticisms pertinent in Jamieson's case and which proved conclusively that a variety of green plants possess the power of fixing atmospheric nitrogen. Later statements by them[3] only confirmed their earlier assertions. They did not accept Jamieson's supplementary statement relative to the mechanism of the fixation in question.

Even the world of science is so conservative as not to have caused a general acceptance of the contentions of Jamieson and Mameli and Pollacci, despite the fact that Moore and Webster[4] and Moore, Webster and Whitley,[5] as well as Wann,[6] have more recently furnished ample confirmatory evidence with fresh water and marine algæ as material. In order to furnish further evidence for securing an acceptance of this new view of nitrogen fixation which is directly opposed to the old established view and to obtain data for the wheat plant which has not been studied in that regard, the writers have recently carried out an experiment resulting as indicated in the general conclusion introducing this brief note. Wheat plants were grown in "Shive's best" solution of an osmotic pressure of 1.3 atmospheres. These solutions were so constituted as to have approximately the same concentration throughout, regardless of whether or not nitrogen was present. The containers for the solution were quart Mason fruit jars and the usual technique was employed. Five wheat seedlings per jar, and six jars of each kind of solution were employed, thus testing thirty plants with each solution. In the case of the solution containing no nitrogen, twelve jars were employed, six of them being kept in the greenhouse until seeds were formed. All the other plants were grown for a period of six weeks only. It is impossible now to go into the many interesting features of this and other experiments which we are conducting on the important subject of nitrogen fixation. Suffice it to say that in a number of series of wheat plants grown without nitrogen and with varying quantities of nitrate, definite evidence was adduced that all the wheat plants fix nitrogen from the air. Even excluding the nitrogen content of the culture solutions at the end of the experiment, because of some irregular data in the analyses, there is a gain of nitrogen from the air which varies in different series from 13 to 21 per cent. of the total amount of nitrogen found in the plant. With the nitrogen in the solutions taken into account, these values will be much larger.

A series of experiments with barley is now being completed, and promises to yield similar results to those obtained with wheat. Legumes and other plants will now be studied, and many other features of the subject investigated. There can be no question now, however, that the teaching of all our books, and nearly all our teachers on the subject to-day are erroneous and must be changed completely to accord with the facts presented by us, and by the other investigators whom we have cited above. As Moore and Webster have put it, authority has too long held sway over logic and experimental fact. It is high time to let those considerations rule. A full, theoretical and historical discussion of this problem will be given in the detailed account of our experiments.

C. B LIPMAN
J. K. TAYLOR

[2] *Atti dell'Instituto Botainco della R. Universita de Paria,* Vol. 13, p. 351.

[3] *Ibid.,* Vol. 14, p. 159, and Vol. 16, p. 197.

[4] *Proc. Roy. Soc. Lond.,* Series B, Vol. 91, p. 201 (1920).

[5] *Ibid.,* Vol. 92, p. 51 (1921).

[6] *Amer. Jour. Bot.,* Vol. 8, pp. 1-29, January, 1921.