designate a particular sound produced by a mosquito as a "call of anger" is to imply a parallelism between the psychological processes of the insect and those of a man who is angry. Whether or not the inference is intentional is immaterial. The psychologically naive reader will unconsciously assimilate it as part and parcel of the presentation and accord it weight equal to that given the objective data with which it is associated.

The objections to anthropomorphic interpretations of animal behavior are several. (1) As noted above, they involve the implicit, but infrequently stated assumption of close similarity between psychological processes in widely separated species. (2) They substitute a process of naming for one of analysis. Thus the labelling of an act as an expression of anger, of fear or of mother love is sometimes regarded as sufficient explanation of the overt response. In actuality no explanation whatsoever has been advanced. (3) Curiously enough anthropomorphic interpretation is most often applied to forms of behavior which are at best only dimly understood in man himself. A great deal of hard work has been and is being done in an attempt to elucidate the stimuli, the mediating mechanisms and the overt expressions involved in human emotions; but the most ardent student of the subject would be quick to admit that we are a long way from a satisfactory understanding of the functions involved. This being the case, one is clearly ill advised to attempt to interpret the reactions of other animals in terms of human emotions.

It is to be earnestly hoped that the investigation of sounds produced by mosquitoes will be pushed ahead, and the resultant findings will be published. We may be certain that the physical characteristics of the calls recorded will be expressed in recognized quantitative terms such as cycles per second, etc. This note is to ask that the behavioral features of the phenomena be accorded equally objective treatment.

FRANK A. BEACH
DEPARTMENT OF ANIMAL BEHAVIOR,
AMERICAN MUSEUM OF NATURAL HISTORY

PRESSURE DUE TO MOUNTING SCIENTIFIC KNOWLEDGE

THE number of fields of science have increased to such an extent that it has become impossible for any one man to become conversant with all of them. Some of the sciences have so developed that it has become difficult, if at all possible, to master a single one of them in its entirety.

As the frontiers of a scientific field expand and recede from the regions covered by experience, the scientific explorer is forced to spend more and more years in getting to the frontier. Unless some radical measures are taken, this situation will soon become so aggravated as to put a brake on the progress of science and force the scientist to become a specialist in an ever narrowing field.

Evidently the remedial measures should aim at securing time-saving means of acquiring knowledge and more efficient use of those means. To this end I suggest, first, making English the international second language for science; second, making English completely phonetic; and third, streamlining and otherwise improving our educational procedures.

In a recent communication, Professor Duane Roller[1] called attention to the need of an international second language for science; he referred to the advantages of English; and suggested that Basic English be used in our scientific periodicals in order to make English the international second language.

No one questions the need for an international second language. Many recognize the advantages of English over other languages, natural or artificial, especially from the point of view of practicability. But few would concede either that Basic English is adapted to the needs of science or that its use in our periodicals could make English an international second language.

Basic English is designed to convey simple ideas. It is not adapted to the expression of the relatively complex ideas of science. Furthermore, the advantage of Basic English is due to its limited vocabulary. This would be largely cancelled by the addition of the extensive technical vocabulary of science.

It is true that simplicity of expression is helpful to all readers, native as well as foreign. But that alone is not sufficient to make English an international language. However simple scientific English is made, a Frenchman will still have to learn Russian if he wants to read scientific papers published in Russian.

English could become the international second language for science if every important research paper written by the scientists of the world were published in English. This could be done if sufficient funds were made available to the scientific societies of the English-speaking countries to enable them to translate and to publish every important research paper submitted by scientists of other countries.

The amount of money required for putting such a plan into effect would be great indeed; but the benefits derived would be even greater—English-speaking scientists would be relieved of the burden of having to learn foreign languages; other scientists would have to learn only one foreign language. Even from a purely financial point of view, the execution of this plan might prove to be a good investment, for the simple reason that the foreign trade of the English-speaking countries would be given a great impetus.

English spelling is not only a stumbling block to

[1] Duane Roller, SCIENCE, 101: 299, 1945.

foreigners, but consumes a great deal of the time of English-speaking children and an appreciable amount of the nervous energy of adults. If a sufficient number of letters were added to the alphabet to make English completely phonetic, much time and energy could be saved for all concerned.

For streamlining and otherwise improving our educational procedures, I suggest:

(1) Elimination of the requirement of every subject in the school curriculum which is not indispensable. Foreign languages, dead or living, for example, are not indispensable as required subjects. It is not necessary to read a book in the original language in order to become effectively acquainted with its contents. It is true that the "flavor" peculiar to the original language is lost in translation. But its price in terms of time has become too high for the majority of students.

(2) Elimination from text-books of every topic which is not indispensable to further progress in the subject or which could be treated more effectively in advanced texts. The methods for finding square roots of numbers and the distance from a point to a line, which are given in text-books on arithmetic and analytics, are cases in point. These highly special methods are not necessary to the student for further progress in the subjects, and their purposes are better served by the more general methods of logarithms and of maxima and minima.

(3) Improvement of the order in which subjects appear in the school curriculum in order to secure better timing and to bring into play the pupil's interest and incentive.

(4) Teaching of the physical and biological sciences continuously from kindergarten through high school. Somehow the natural curiosity of the child is being destroyed and the common sense of the pupil is being bred out of him, as applied to his studies. The teaching of science continuously in primary and secondary schools would help correct these conditions. The elements of science interest children. Science deals with the tangible and the concrete; therefore it is well adapted for training children to make use of their common sense in their studies.

In colleges and universities, the majority of students avoid science courses whenever possible, because they find them difficult. As a result, most of our leaders in education, in religion, in industry and in other controlling fields are generally ignorant of science and of the scientific method of approach to problems of life; they are untouched by the scientific spirit. Most of the major ills of our age can be ascribed to this cause.

If science were taught continuously throughout the school years, college freshmen would be familiar with many of the scientific terms and concepts. Consequently they would not find college courses as difficult as they do now.

(5) Greater use of the laboratory method in school science. The laboratory method could be introduced even in the lowest grades. In teaching the multiplication table, for example, the child could be asked to place blocks in rows and columns of 4 and to count the resulting number of blocks. Thus he could not only discover that $4 \times 4 = 16$, but he could also be helped to see that multiplication is a short cut to repeated addition of equal numbers. He could at the same time learn what the square of a number and the area of a square mean.

(6) Greater use of the historical and philosophical approach to scientific subjects in college. The college student may now take a course in the calculus without knowing the problem which led Newton to the discovery of the method of the calculus. He may go through a course in physics without learning how Galileo happened to come to the concept of inertia. He may major in a science, yet may not know what is meant by the scientific method.

(7) Placing greater emphasis on understanding general principles and on learning general methods. Some text-books are more in the nature of hand-books than text-books. Trigonometry books are about the worst in this respect. Some of them give three, even six, formulas to express the Cosine Law, when one would be sufficient. Most of them give dozens of formulas for the functions of large angles, when a simple rule is all that is needed. Most mechanics books, on the other hand, make the subject appear unnecessarily complicated, by classifying forces into a large number of types and giving them different names. Problems may be classified into types, but forces can not be so classified, because the latter have no types. Furthermore some of the names given are patently absurd—for example, "imaginary," "fictitious" and "lost" forces.

It is not necessary to extend this list any further. The important point I want to stress is this: There is a crying need and a great opportunity for creating conditions which would make it possible for the future scientist to reach the frontiers of his specialty earlier in life and at the same time to obtain a broader education.

H. M. DADOURIAN

TRINITY COLLEGE,
HARTFORD, CONN.

THE SHORTAGE OF SCIENTIFIC PERSONNEL

MUCH has been said[1] about the scarcity of trained

[1] M. H. Trytten, *The Scientific Monthly*, January, 1945, p. 37.