

BECAUSE of decreased enrolment and war conditions the Commissioner of Education, with the approval of the Governor, has decided to close temporarily the regular sessions of the State Teachers College at Hyannis as of August 31, 1944, and permit the Massachusetts Maritime Academy to use its facilities exclusively for the training of personnel for the Merchant Marine and the United States Navy, and for vocational training which may be related to the courses of instruction at the academy.

THE sum of \$25,000 has been appropriated by the Michigan Legislature for research in forest products to be carried out by the Michigan Planning Commission.

COLUMBIA UNIVERSITY has received a gift from the Commonwealth Fund of \$14,500 to be applied to the study of respiratory physiology in the department of medicine.

THE Toledo Hospital Institute of Medical Research of Toledo, Ohio, is the recipient of a grant made by the Snyder Ophthalmic Foundation of \$6,500 per year for a period of two years for research on the physiology of the eye especially in relation to glaucoma. The grant will be extended for a longer period

depending upon the results obtained in the first two years. Because of the war, research will be delayed until a physiologist with specialized training in the eye will become available.

THE Imperial Chemical Industries, Ltd., has made a gift to the University of Oxford of £7,200 a year for seven years to establish research fellowships in chemistry or physics. An electing committee will be appointed to carry out the objects of the gift.

CHARLES BROTHERTON, head of the Yorkshire chemical firm of Brotherton and Company, Limited, has agreed to subscribe £1,000 a year under deed for seven years for the establishment of a research fellowship in chemistry tenable at the University of Leeds, and a further £1,000 for seven years for a new lectureship in chemical engineering. In addition, he has subscribed £2,000 for the provision of the necessary extra equipment.

GROUND will soon be broken for the new hospital of the School of Medicine of Georgetown University, which will be erected directly to the east of the school. This structure will have a 400 bed capacity and has been planned with a view to eventual expansion to 600 beds. The project is being financed jointly by the Federal Works Administration and by the university.

DISCUSSION

ECHOLOCATION BY BLIND MEN, BATS AND RADAR

THERE are a number of situations where men or animals can not see clearly but nevertheless succeed in finding their way about by making sounds and detecting echoes from solid objects which are still some distance away. Many blind persons develop in the course of time a considerable ability to avoid obstacles by means of auditory cues received from sounds of their own making, such as footsteps or the tapping of a cane. Their skill can be drastically impaired by ear plugs or by distracting noises.^{1, 2} Bats can fly through the total darkness of caves without striking the walls or the jutting stalactites which may complicate their path. The bats emit a supersonic cry (inaudible to human ears because its frequency is from 30,000 to 70,000 c.p.s.) and orient themselves by means of the echoes of this cry which return to them from any obstacles which lie ahead.^{3, 4, 5}

Since there is no convenient term available to describe this process of locating obstacles by means of

echoes, I suggest the word *echolocation*, not only for the abilities of bats and blind men, but for several other analogous cases which I shall mention below. The meaning of this word, and a corresponding verb *to echolocate*, are likely to be clear when first heard or read, since they are formed simply by joining *echo* and *locate*. It seems best to accent the first syllable in order to make clear that the word *echo* is employed. These terms would fill a definite need, since they describe an important and general process for which one otherwise requires long phrases or whole sentences.

Man has developed instruments for echolocation which are far more effective than the blind man's tapping cane. In fog-bound coastal waters the captain of a ship often blows his whistle and listens for an echo from cliffs or rocks which he suspects are near. Even such small objects as buoys are said to be detected in this way by men with long experience. The depth of water under a ship's hull is often measured by the sonic depth-finding apparatus or fathometer, an instrument which sends down sound waves through the water and measures its depth by timing the returning echoes. This same instrument has also been used by fishermen to echolocate schools of fish beneath their vessel.⁶ Submarines are detected by apparatus work-

¹ S. P. Hayes, "Contributions to a Psychology of Blindness," 49-63, 1941.

² M. Supa, M. Cotzin and K. M. Dallenbach, *Am. Jour. Psych.*, 57: 133-183.

³ H. Hartridge, *Jour. Physiol.*, 54: 54-57, 1920.

⁴ D. R. Griffin and R. Galambos, *Jour. Exp. Zool.*, 86: 481-505, 1941.

⁵ R. Galambos, *Sci. Monthly*, 56: 54-57, 1943.

⁶ A. L. Tester, Bull. 83, Fisheries Res. Board of Can., Ottawa, 1943.

ing on the same basic principles, although the developments by which such devices have been perfected are not made public for obvious reasons.

Nor is the process of echolocation limited to sound waves. The "absolute" or radio altimeter used in airplanes is the counterpart of the fathometer except that radio waves are employed as the "probing" signal. A radio signal is sent out from the airplane and electronic devices measure the time required for this signal to be reflected back as an echo, either from the ground below the airplane or from a mountain ahead of it.

Finally we have radar, a refinement of the radio altimeter so beautifully perfected that it can echolocate airplanes at great distances by sending out radio waves and picking up the reflected energy returning from the distant aircraft. It would be presumptuous for a biologist to discuss radar in detail, even if information were available; but it does seem clear that the same fundamental process is involved in all these phenomena, from the bat's supersonic cries and the blind man's tapping cane to the intricacies of radar.

Echolocation may be employed in still other situations. Owls or flying squirrels, for instance, could use it to advantage, and future studies may disclose that they have evolved some variant of the bat's method of finding its way about. Unsuspected forms of echolocation may be found in nature or developed by human technology, and the use of a single unifying term can help clarify our ideas and stimulate such future developments.

DONALD R. GRIFFIN

BIOLOGICAL LABORATORIES,
HARVARD UNIVERSITY

MORTALITY AMONG GEOLOGISTS

IN SCIENCE for May 26, 1944, there appears a short article by Professor William H. Hobbs under the title "Unusual Mortality among Geologists." This is interesting but perhaps of very little scientific value, and Professor Hobbs's suggestion that the war may be responsible for the phenomenon seems a bit far-fetched. Another explanation seems more reasonable.

Professor Hobbs has taken a period of a little over five months, from November 16, 1943, to April 19, 1944, and finds that sixteen fellows of the Geological Society of America died during that period. I have no statistics at hand as proof, but I believe these winter months are much more hazardous to elderly people than the summer months. Professor Hobbs does not compare the total for this five-months period with similar periods of the past, but with annual totals. Only two of these sixteen deaths occurred in 1943, so if we stick to annual totals it is quite probable that 1943 will show nothing unusual, but 1944 may easily show a high. But is there any reason

why it should not? Every phenomenon which shows variations must have highs and lows, and some high is bound to be greater (or equal to) any other high. It might easily be that 1944 will show one of those highs in the death-curve of fellows of the Geological Society of America.

The ages of these sixteen deceased fellows range from sixty-four to ninety-four. This means that they were in college roughly from 1870 to 1900. Now it is well known that that was the period in which students were turning from the classical studies to science and engineering. That was the time when the number of students in the colleges and universities, especially in the Mid-west, increased by leaps and bounds, and that was the time when great geologists like Thomas C. Chamberlin, Joseph Le Conte and John C. Branner, to mention only three under whose influence I happened to come, flourished and attracted many students to their classes. It is not surprising but inevitable that some fifty or sixty years after those sixteen fellows were in college there should be a maximum in the death curve of geologists. $\frac{1}{2}(1870 + 1900) + 59 = 1944$. It may be permissible to point out what appears to be a small error in the article under consideration. The last name in the table of deceased fellows is that of R. C. Wells. In the second paragraph below there are given the names of three geologists, not fellows of the Geological Society, who died during the period under consideration. R. C. Wells is one of these names. Of course there might have been two geologists of the same name and initials who were born and died on the same days, but the probabilities in favor of such an event would seem to be rather small.

If we want to be sticklers for accuracy, then the name of F. B. Hanley should not have been included among the three geologists because he died on April 24, which was after the period under consideration.

The suggestion of Professor Hobbs that the phenomenon considered might be laid to the war seems almost fantastic. Most of these men were too old to have sons in the present war and it seems highly improbable that worry over the destruction of cultural institutions and values could have played more than a very minor role in the case.

Why drag in the war to explain what appears to be a perfectly natural phenomenon taking place in the orderly course of events?

SIDNEY D. TOWNLEY

STANFORD UNIVERSITY

REVISTA SUDAMERICANA DE MORFOLOGIA

THIS *South American Review of Morphology* is a new biennial publication of great scientific value