reported at approximately 100 miles an hour. The ship was headed west and into the wind.

I understand in talking with officers that during this part of the storm one wave would be leaving the *Leviathan's* stern, another would be under her amidships and she would be entering on a third.

The *Leviathan* is 950 feet long.

From this you may be able to figure the length of the waves or their height.

Very truly yours,
DAVID A. BURKE,
Assistant General Manager,
United States Lines

On November 28, Thanksgiving Day, the S. S. *Leviathan* was about 1,300 miles (nautical) from Cherbourg and about 1,000 miles from American shores; on the following day she was about 300 miles nearer land. Long ago Stevenson pronounced a formula connecting the maximum height of waves with the "fetch" of the wind in deep water for distances from shore between 100 and 1,000 miles. The formula is as follows: $H=1.5\sqrt{f}$. "H" is height of wave and "f" is the fetch of the wind. On November 28 the fetch of the wind was 1,000 miles, and on the next day it was 700 miles. Of course we have no assurance that the wind blew actually over the whole fetch from the mainland to sea, but on that supposition on November 28 the waves might have been 50 feet high and on the 29th 40 feet high. It happens that on the 27th the wind was from the north, which caused waves rushing transverse to the great storm waves here considered and which persisted in spite of the new series of waves. Consequently there were probably peaks and troughs upon the main waves which might well increase their height 10 or 15 feet.[1] As a result of these considerations the waves may have been as great as 60 feet in height from trough to crest, although it is generally agreed that in the North Atlantic Ocean forty-foot waves are of extreme size. Another line of attack arises from the length of the waves. According to the ship's officers these waves were commonly 475 feet long. Judging from critical reports of other storms it is likely that some waves were over 600 feet long. Waves of such a size are between 35 and 45 feet high irrespective of cross waves or breaking peaks. If the wave peak was actually as high above the trough as the camera when the photograph was taken the wave must have been considerably over 60 feet high, because although the camera was pointed down from the 60 foot elevation above the ship's water-line it was considerably more than 60 feet above the bottom of the trough of the wave.

From another of Stevenson's formulae the velocity of the wave may be computed. Although waves commonly run almost as fast as the wind which makes them, the extreme speed of the wind, 100 miles per hour, caused a departure from this common rule. The velocity of the wave is related to its length as follows: $V = \sqrt{5.123L}$.

Putting the value of 475 feet for "L" the velocity of the waves becomes 50 miles per hour.

It is a significant commentary on modern naval architecture and marine operation that the S. S. *Leviathan* was able to advance 300 miles in twenty-four hours, steaming against a wind of 100 miles per hour and plowing against waves which were running on an average 475 feet long and 40 feet high with a velocity of 50 miles per hour.

An examination of the evidence available indicates that this was one of the most violent storms ever recorded on the North Atlantic Ocean as far as size of waves is concerned.

T. T. QUIRKE

UNIVERSITY OF ILLINOIS

[1] Wm. Scoresby, British Association for the Advancement of Science, 1850.

HEARING BETTER IN THE PRESENCE OF A NOISE

Do certain hard-of-hearing persons hear better in the presence of a noise? Much has been spoken and published supporting the affirmative and negative answers to this question.[1] Yet, for some reason, no one has answered this question definitely and adequately on the basis of experimentation. Otologists, physicians and many other people, including those who have hearing impairments of a fixative type—usually called otosclerosis—quite generally have believed that otosclerotic hard-of-hearing people actually do hear better in the presence of a noise. Some very scholarly otologists have attempted to explain this phenomenon by supposing that the gross vibrations of the noise act upon the ossicular chain in such a manner as to set it into vibration, which makes this conductive mechanism of the middle ear a more efficient vehicle for transmitting speech or music to the internal ear. The noise, they claim, is supposed to increase the sensitiveness of the ossicular chain in much the same way that tapping or jarring the old form of "coherer," used for the detection of radio waves, increased its sensitiveness.

Kranz[2] and Fletcher[3] recently have advocated that these hard-of-hearing people actually do not hear better in the presence of the noise, but that the noise

[1] Three notes regarding this question have appeared in SCIENCE during the past six months: G. W. Boot, Oct. 17, 1924; F. W. Kranz, Dec. 12, 1924; B——, March 6, 1925. See also H. Burger, ''De la Paracusie de Willis,'' *Rev. de laryngol d'Otol. et de Rhinol.*, 38: 561, 1917.

[2] F. R. Kranz, *Laryngoscope*, March, 1924.

[3] H. Fletcher, *Volta Review*, September, 1924.

is less of a disturbing factor to the hard-of-hearing people than it is to normally hearing people, and, therefore, they enjoy a relative advantage for hearing in the presence of a noise.

In an attempt to answer this question definitely and completely, the writer, in cooperation with Dr. I. H. Jones, has conducted some experiments. These experiments indicate quite conclusively that in the presence of a noise, otosclerotic hard-of-hearing persons sometimes *do hear conversation better than persons with normal hearing,* but that these same hard-of-hearing persons *hear conversation less well in the presence of a noise than they do in the quiet.*

First experiment: An otosclerotic hard-of-hearing person, having 40 per cent. of normal hearing for low-pitched tones and 60 per cent. of normal hearing for high-pitched tones, a person with normal hearing and the writer went into a large, reverberant concrete garage. The motor of a large automobile was set running at a very high speed, and the "cut-out" was opened, so that a very loud disturbing noise resulted. The hard-of-hearing person and the person with normal hearing were placed at equal distances from the writer, and the latter gradually raised his voice until he could be heard by one of the listeners. The hard-of-hearing person actually could hear the conversation slightly better than his normally hearing companion.[4]

Second experiment: The same otosclerotic individual was then tested for his minimal threshold of audibility, for representative tones throughout the speech range, first in a quiet room and then with various amounts of noise in the room. Whenever the noise became loud enough to be heard by him it decreased his auditory acuity for tones of all pitch; that is, the tones had to be made louder before he could hear them. The louder the noise, the louder the tones had to become before they reached his minimal threshold. Similar tests, with the same results, have been conducted upon six other persons with marked fixative impairments of hearing.

Third experiment: Word articulation tests, similar to those employed by telephone engineers in testing the speech transmission efficiency of a telephone circuit, have been applied to three otosclerotic hard-of-hearing individuals, first in a quiet room, and then, using the same loudness of speech, in the presence of an interfering tone or noise. Tones of 128 d.v., 256 d.v., 512 d.v. and 1,024 d.v., at various levels of loudness, and typical noises at various levels of loudness, were conducted by means of a pair of head phones to the ears of the individuals under test. Any kind of an interfering tone or noise, in every instance, reduced the percentage word articulation. There was no evidence whatever to indicate that these individuals could hear better in the presence of any kind of tone or noise, but there was abundant evidence to indicate that they could not hear so well.

These three experiments, therefore, seem to offer a satisfactory answer to this much discussed question.[5]

Thus, the first experiment indicates that in a noise of sufficient intensity, an individual with a fixative hearing impairment can hear conversation as well as or better than an individual with normal hearing. But also, as the second and third experiments indicate, the person with impaired hearing actually hears either tones or speech less well in the presence of a noise than he does in a quiet place; that is, either tones or noises interfere with his ability to hear other tones or conversation, and they interfere qualitatively and quantitatively in the same manner that tones or noises interfere with normally hearing persons.

In a certain sense, these two conclusions may seem contradictory, but the following facts, which include those advanced by Fletcher and Kranz, offer a satisfactory explanation of the two conclusions:

(1) A fixative type of hearing impairment is characterized by a much greater loss of acuity for the low-pitched tones than for the high-pitched tones. Further, recent experiments have shown that low-pitched tones produce a greater interfering effect upon speech than do high-pitched tones.[6] Therefore, the individual with this type of impairment is relatively "deaf" to those frequencies of the noise which produce the most damaging interfering effect.

(2) Again, since the individual with a fixative impairment has greater acuity for the high-pitched tones than for the low-pitched tones, and since good hearing for the higher tones—above 500 d.v.—is more important for the hearing of speech than good hearing for the lower tones, the individual with this type of impairment has relatively good hearing for those frequencies which are most important for the hearing of speech.

(3) In a noise, the loudness of conversation is in-

[4] Since this article was written similar qualitative tests have been conducted upon three other otosclerotic persons. These tests indicated that these hard-of-hearing persons, in the presence of a very loud noise, heard conversation approximately as well as, but no better than, persons with normal hearing.

[5] A more complete account of these experiments, including a larger series of patients tested, with quantitative data, will be published at a future date in an appropriate journal.

[6] Knudsen, "The interfering effect upon speech of tones and noises," *Physical Review*, about July, 1925. Paper read before American Physical Society, Pasadena meeting, March 7, 1925.

creased. The loud conversation, and also the loud noise, actuate the cochlea of the normally hearing individuals with much greater intensity than they do the cochlea of the individual with a conductive impairment. Therefore, because of the non-linear response of the ear, the cochlea of the normally hearing individual will be overloaded and hence will suffer both a relatively greater interfering effect from the noise and also a greater distortion of the speech than will the person with a conductive impairment.

There is another factor, which, though irrelevant to the experiments and conclusions described in this communication, contributes immensely to the advantage enjoyed by a person with a conductive impairment when he converses in the presence of a noise with a person with normal hearing. The normally hearing individual hears the noise with its full intensity, and therefore will increase the loudness of his voice relatively more than will the individual with a conductive impairment, who hears the noise with greatly diminished intensity. This also is the reason why, in a noise, it is difficult for a person with normal hearing to hear the conversation of a person who has a conductive hearing impairment.

In contrast to those who have conductive hearing impairments, persons with perceptive impairments claim they hear less well in the presence of a noise than in the quiet. Many observations upon individuals having perceptive impairments confirm this claim.

It is well established that individuals with nerve deafness suffer a much greater loss of acuity for the high-pitched tones than for the low-pitched tones. Further, the defect is one of the end organ and not of the transmitting mechanism. These two facts, together with the contrary of the facts stated in "1" and "2," explain why this type of "deaf" person does not derive the benefit from a noise that the person does who has a conductive impairment.

Vern O. Knudsen

Department of Physics,
University of California,
Southern Branch

THE BARRO COLORADO ISLAND LABORATORY

Many biologists and other scientists probably do not yet realize how easy and safe it now is to visit a new tropical world in Panama. To one like the writer, whose experience had been limited to the temperate zone, it is a revelation to observe what nature can do under constant summer temperatures and ample rainfall in the torrid zone. The vague qualms one may feel about fevers, dangers, snakes, insects and the heat are found to be largely unfounded when he reaches the Canal Zone; he finds that he may comfortably and safely wander along the jungle trails of the island. While my own interest in visiting the Isthmus was especially the fungi, I found upon arrival that, abundant though the fungi were, there was an even greater interest and value in observing the broader phases of plant and animal life. Incidentally, there are also the canal, the quaint cities and country and many other excellent reasons which make the trip profitable as well as pleasant. The National Research Council, Dr. Barbour, of the Museum of Comparative Zoology, Cambridge, Mass., and Mr. Zetek, the resident custodian, deserve the thanks of all of us for the opportunity they have provided.

G. R. Bisby

University of Manitoba
Winnipeg, Canada

EVOLUTION AND THE BIBLE

There have recently been held in several of our Pacific Coast cities debates between the Reverend W. B. Riley and E. A. Cantrell on the question of evolution *versus* the Bible. The evolution side of these debates has been argued by Mr. Cantrell, who, according to press reports, is a representative of "The Science League." The public and press seems to be of the opinion that said Science League is a part of the American Association for the Advancement of Science or has some connection with it, though this is not the case.

In the above-mentioned debates, according to press reports, Mr. Cantrell attempts to reconcile the tenets of the Bible with the fundamental principles of science. He naturally fails to make a case and at the close of these debates a vote is taken with a result of about five to one in favor of the anti-evolution side.

As a member of the American Association for the Advancement of Science I wish to protest against such methods. The cause of science is in deplorable straits when it must be defended by such so-called scientists who would attempt to reconcile it with primitive Jewish folk lore.

Nothing has happened in a decade (in half a dozen decades) calculated to harm the cause of science more than the equivocal position of certain scientists of high station, who state that there is no conflict between science and religion (meaning, of course, the Jewish-Christian religion). Their stand in this regard has been followed by various publicists equally devoid of moral courage.

Ira D. Cardiff

Yakima, Washington