The Bacteriology of Diphtheria. Including Sections on the History, Epidemiology, and Pathology of the Disease, the Mortality caused by it, the Toxins and Antitoxins, and the Serum Disease. By Drs. F. Loeffler, A. Newsholme, F. B. Mallory, G. S. Graham-Smith, G. Dean, W. H. Park, and C. F. Bolduan. Edited by Prof. G. H. F. Nuttall and Dr. G. S. Graham-Smith. Re-issue with Supplementary Bibliography. Pp. xx+718. (Cambridge University Press, 1913.) Price 15*s.* net.

THE first edition of this exhaustive work was reviewed in the issue of NATURE for April 29, 1909 (vol. lxxx., p. 243). The editors point out in the present edition that the conclusions arrived at in the papers which have been published since the first appearance of the volume have mainly confirmed the opinions advocated in it; and consequently they decided only to add a supplementary bibliography of eight pages, recording the most important work published since 1908. In many instances the contents and conclusions of the papers included in the bibliography are indicated sufficiently in their titles; in other cases a brief summary of their contents has been added.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Migration Routes.

THE experience gained from flights on aëroplanes and from the behaviour of airships may throw some light on why migratory birds follow certain routes. Pilots in aëroplanes can easily see rivers and ponds, and these form better guides than roads and railways; main roads, now usually tar-coated, are not conspicuous, while the lighter coloured by-roads are more easily seen. There is evidence that migration routes are often along coast lines and river valleys; these are most conspicuous features in an uninhabited country, and birds when flying in the daytime below the clouds could have no difficulty in following them by sight.

When flying at night, or above the clouds, birds would be able to follow the coast-line by the sound of the waves breaking on the shore. Dr. Gadow believes, both from theoretical considerations and from his observations, that birds have very acute power of hearing faint sounds. Thrushes apparently are able to detect earthworms by the noise they make just before they come out of their holes in the earth. Owls have remarkably well-developed ears, both external and internal, and the silence of their flight perhaps has been partly developed to enable them to detect slight sounds. Birds no doubt appreciate the songs of their mates, and parrots have the power of reproducing sounds with great exactness. Dr. Gadow adds, that judging from the structure of the ear, most anatomists think that the power of hearing in birds is much inferior to that of mammals. He does not, however, agree with this opinion.

Observations on sound from an aëroplane are impossible because of the noise of the engine and propeller. But from a balloon sounds can be heard easily. People shouting have been heard at 4500 ft.; a gun at 8200 ft.; a dog barking at two miles; a band playing at 11,800 ft.; a railway train at 4900 ft.[1] Other observers have noticed the barking of dogs, the crowing of cocks, and the bleating of sheep when high up.

Mr. Griffith Brewer heard on one occasion the sound of the sea breaking on the shore. He was over the English coast with an offshore wind and a calm sea underneath him, and the sound he heard came from the breaking of the waves on the French coast at least twenty-five miles away. He was amongst the clouds in falling snow, and could see nothing. As the wind carried him along over the sea the sound of the waves gradually increased, and this was the only assurance of his continued approach to the French coast.

Even in calm weather the sound of the waves would be easily heard by birds when at a considerable height. Those who have lived a short distance inland are familiar with the sound from the shore on calm nights. When there is much wind the waves breaking are not heard because of the sounds produced by the wind in the trees or buildings near. The intensity of the sound from a single source, such as a dog barking, will vary inversely as the square of the distance, but if the sound comes from a line instead of a point its intensity will only vary inversely as the distance. Mr. Mervyn O'Gorman has pointed out that this is one of the reasons which accounts for the great distance to which the sound from the sea breaking on the shore will carry.

Osborne Reynolds has discussed the refraction of sound caused by wind and also by the variation of the temperature of the air at different heights above the ground.[2] The refraction caused by wind reduces the carrying power of the sound to a place on the earth's surface to windward. Usually the temperature of the air falls with increasing height, and this reduces the carrying power of the sound in all directions to places on the earth's surface. When the direction of the sound makes a large angle to the surface of the earth the intensity of the sound will not be reduced. On one occasion during his experiments the calls from the occupants of a boat were heard on a yacht more than five miles distant. In this case the direction was horizontal, and no doubt the conditions were exceptionally favourable for the transmission of sound, but we should expect the conditions generally to be good for the transmission of sound in an upward direction, where there are no solid objects to make sound shadows.

It seems then that birds can have little difficulty in following coast-lines by day or night.

Migrating birds, however, can only follow rivers by sound when these are so wide as to have waves breaking on their shores or so rapid that sufficient noise is made by the water tumbling over rocks.

Mr. Griffith Brewer tells me that at night ponds and rivers are indistinguishable from grass fields even in bright moonlight, except that the surface of the water acts as a mirror in which the brilliant reflection of the moon or even of a star is seen. This can only be an efficient guide to migrating birds on moonlight nights with a clear sky and when they are flying in such a direction that the image of the moon in the water is within their field of vision. Most birds have their eyes at the sides of their heads,[3] and this would give them the power of watching the reflection of the moon in a river or sea when it is

[1] Report on Eight Balloon Ascents in 1862 by James Glaisher, F.R.S. B.A. Report, 1862, p. 490.

[2] See "Papers on Mechanical and Physical Subjects," by Osborne-Reynolds, F.R.S., pp. 89 and 157.

[3] Certain carnivorous birds have their eyes more in front; birds follow the same general rule as other animals; the eyes of the hunter are in front which must help him to see his prey, and the eyes of the hunted are at the side of the head to enable him to watch his pursuer.