

FLOODS OF SEPTEMBER 1938 IN NEW ENGLAND

THE hurricane which visited New England in September 1938 is rather artlessly described in a massive volume of 562 pp. as "the greatest catastrophe since settlement by the white man"*. The loss of life was very heavy and the material damage by flood, wind and wave exceeded three hundred million dollars. The greater part of the damage was caused by flooding of the rivers resulting from heavy rain, and coming so soon after the great floods of March 1936 it caused much alarm. The U.S. Geological Survey has accordingly collected all the available information about rainfall and river-levels as a basis for the design of protective measures for the future.

The antecedent conditions were unfavourable but not in themselves dangerous. In the preceding months rainfall had been above normal, and by September 11 there was an accumulated surplus of moisture in the ground. Heavy rain during September 12-16 added to this, but though the rivers ran bank high there was no flooding. On September 16 there was even some improvement, but from September 17 onwards the weather was consistently unfavourable. On September 19 a trough of low pressure lay over New England in which moist tropical air moved northwards, giving falls exceeding 5 in. in twenty-four hours. Meanwhile a tropical hurricane was moving rapidly northwards near the coast. As a rule these hurricanes keep well to the east, but this one was diverted into the open trough of low pressure, and on September 21 moved rapidly inland towards the Canadian border. On the eastern side of the centre the winds reached hurricane force, doing widespread damage, and the rainfall was torrential, but with the passage of the centre the rain ceased abruptly. In the twenty-four hours ending at 6 p.m. on September 21, 6 in. or more fell over 1,020 square miles, and floods which, though severe, might have been manageable, burst all bounds.

Rainfall charts are given day by day and again for every twelve hours, but since the effect of flood rains is largely cumulative, greatest interest centres in the map for the whole period September 17-21. The distribution is remarkable, for while there was a rainfall of 6-10 in. in these five days over a very wide area, the greatest amounts of 10 in. to more than 17 in. were confined to a comparatively narrow belt along the hurricane track northwards from Long Island, comprised mainly within the basins of the Connecticut, Merrimack and Thames Rivers. Over an area of 100 square miles in Connecticut and central Massachusetts the rainfall exceeded 16 in., equivalent to the total average rainfall in London from January to September inclusive. On the eastern side of this belt the rainfall diminished almost abruptly, so that the coast of Massachusetts received only a few inches, but on the western side the decrease was more gradual and flooding extended for some distance with decreasing severity. In many places on the smaller streams in the central belt the crest of the flood reached levels several feet higher than any previously recorded. The tables of flood height and discharge which make up a great part of the book show instances of discharges which were only a few

cubic feet per second per square mile of drainage area on September 18 and 100 cub. ft. on the morning of September 21, but had risen to 400 or 500 cub. ft. a few hours later. On the larger rivers the rise was naturally slower as various tributaries came in at different stages, but the cumulative effect was as great. Under the pressure of the water, dams and bridges gave way and the rivers spread over their flood plains, destroying roads, railways and houses; the damage is vividly shown by a fine series of photographs.

The coasts naturally did not suffer from river flooding, but they were swept by a great storm wave, which in the eastern areas coincided with the normal time of high tide and rose to heights of 10 ft. and, where the waters were heaped up in narrow channels, more than 17 ft. above the average level of high water; New York's holiday coast was devastated, scores of houses being completely demolished.

The flood problem of rivers in populous country is one of great complexity. To enable the waters to flow away freely and naturally, the flood plain should be kept unobstructed, but the life of the towns and villages depends on the river, and encroachments are hard to avoid, while it is to these low-lying settlements that the danger is greatest. Reservoirs, whether constructed specially for the purpose of controlling flood water or for other purposes, play a useful part in minimizing the rise, but if the river sweeps away the obstructing barrier and empties the reservoir, the sudden influx of stored water may add to the catastrophe; in fact, many of the curves of flood height show a double crest due to this cause. The volume of flood water depends on the absorption of the ground as well as on the rainfall; the great flood of March 1936 was magnified by the melting of the snow and by the imperviousness of the ground, which threw practically the whole of the rain-water into the rivers; by contrast in September 1938 the ground, in spite of its previous soaking, managed to absorb a good deal of the earlier rainfall, though it could not cope with the torrential downpour of the last day.

Hurricanes have visited New England before, and will doubtless do so again, but this detailed record compiled by the U.S. Geological Survey will at least provide American engineers with the data for plans to minimize, though they are unlikely to be able entirely to avert, the effects of future visitations.

C. E. P. BROOKS.

BIOGEOGRAPHIC DIVISION OF THE INDO-AUSTRALIAN ARCHIPELAGO

ON April 16 and 30 a discussion was held by the Linnean Society under the chairmanship of the president, Dr. E. S. Russell, on "the biogeographic division of the Indo-Australian Archipelago, with criticism of the Wallace and Weber lines and of any other dividing lines, and with an attempt to obtain uniformity in the names used for the divisions". The following papers were contributed: Mr. J. B. Scrivenor, "Geological and climatic factors affecting the distribution of life in the Indo-Australian Archipelago"; Mr. I. H. Burkill, "A historic account of the divisions which have been proposed"; Dr.

* Hurricane Floods of September 1938. U.S. Geological Survey Water-Supply Paper 867, 1940.

Malcolm A. Smith, "The divisions as indicated by Vertebrata"; Dr. A. S. Corbet, "The divisions as indicated by the Insecta"; Mr. H. K. Airy Shaw, "Some general considerations from the botanic standpoint"; Dr. P. W. Richards, "On the ecological segregation of the Indo-Malayan and Australian elements in the vegetation of Borneo"; Dr. F. E. Zeuner, "The divisions as indicated by the distribution of insects in relation to geology".

The object of the discussion, in so far as it aimed at uniformity in principle, can be said to have been attained because there was a general opinion that division into biogeographical sub-regions was preferable to divisions by lines such as the Wallace and Weber lines, but no agreement was reached as to what those sub-regions should be. At the same time it was held that the Wallace and Weber lines retained some importance, but that the Wallace line as drawn by him to pass from the northern end of the Macassar Strait to the east of the Philippines should be modified so as to pass along the deep channel between Mindoro and the small islands off the northern end of Palawan. The southern termination of the Wallace line between Bali and Lombok has been criticized as unimportant by Dutch zoologists, none of whom, through the unfortunate force of existing circumstances, could take part in the discussion. It was also agreed that at the height of the Pleistocene glaciation the Sunda and Sahul shelves were dry land but that there is no precise knowledge yet how far the sea rose above its present level when the ice melted. The discussion was partly directed to considering the validity of Wegener's theory of continental drift as applied to the particular hypothesis that the Australian continental block with New Guinea as a spear-head has broken through what was once a continuous chain of islands now represented by the islands of the Banda Arc and the Bismarck Archipelago. An inquiry as to the general opinion of geologists about continental drift elicited a reply that the theory explains so much that there is a feeling that it must be true but that as yet there is nothing that can be called proof of it. It was agreed that the Indo-Australian Archipelago consists of two comparatively stable areas, the Sunda and Sahul shelves, with a very unstable area, sometimes called 'Wallacea' in between, where mountain-building is now in progress and where islands with rugged contours alternate with areas of deep sea. The Wallace line roughly follows the edge of the Sunda shelf and the Weber line that of the Sahul shelf; but the latter is drawn so as to pass on the west of the Kai Islands and on the west of Halmahera, whereas the edge of the Sahul shelf is to the east of those islands.

Mr. Burkill gave an interesting survey of proposed zoological and botanical divisions, the former following vertical and the latter horizontal lines. He mentioned doubts expressed by Wallace himself about his line and especially about the position of Celebes with regard to it, which he said ("Island Life", 1895 ed., p. 462) might perhaps with equal propriety be left out of both the Oriental and Australian regions. Weber's line was the result of studying the distribution of freshwater fish, but had been slightly modified by Pelseneer and Merrill, while Lydekker would have placed Halmahera west of it.

The unstable 'Wallacea' is a broad transition belt in which a mixture of fauna and flora occurs. Dr. Malcolm Smith emphasized the evidence given by the re-establishment of life on Krakatau after the 1883 eruption of the ease with which organisms, large

and small, could have travelled by water and air from the continental areas to the islands in this belt. He said that while the Sunda vertebrate fauna is very like that of Asia, that of New Guinea is not so similar to that of Australia because climatic and geographical conditions differ to a greater extent.

Mr. Airy Shaw said that lowland and mountain floras in the Indo-Australian Archipelago may have quite different affinities with the floras of adjacent regions. Speaking of the floras within the Archipelago, he said that the lowland floras of Sumatra, the Malay Peninsula, Borneo and the Philippines are much the same, but that of Java differs from them. The mountain floras of Sumatra, Java and the Lesser Sunda Islands resemble each other but differ from the mountain flora of Borneo. Dr. Richards, as a result of his work in Borneo, thought that the Australian element has only been able to penetrate into the Archipelago where the soil is poor, and he thought that the Wallace line only holds good at all in so far as it agrees with the divisions of climatic and physical factors.

Dr. Corbet and Dr. Zeuner both dwelt on the importance of butterflies in connexion with the discussion and described the distribution of certain genera. The former proposed a division into sub-regions which he named the Malaysian, the Philippine, the Celebes, the Moluccas and New Guinea, and the Lesser Sunda Islands sub-regions. These differed from Dr. Malcolm Smith's proposal of Malaysian, Philippine, Indo-Chinese, Papuan, Austro-oriental and Australian sub-regions. Dr. Zeuner thought that the Wallace and Weber lines could not be defined biologically and that the Australian continental block is approaching Asia.

In a general discussion which followed the last paper read, Mr. Norman cited the evidence of the distribution of freshwater eels as bearing on the earlier relations of land and sea in this area. The importance of co-operation between biologists and geologists was mentioned, but one speaker pointed out that neither must rely on the other too much for proof of their theories but must rely chiefly on their own efforts.

J. B. SCRIVENOR.

CARNEGIE INSTITUTION OF WASHINGTON

THE Year Book of the Carnegie Institution of Washington No. 40 covers the year July 1, 1940-June 30, 1941, and includes the report of the president as well as the reports of departmental activities and co-operative studies.

In his report, the president refers to the retarding of the attack on many problems on the border line between physics and biology, to implement which the construction of a large cyclotron has commenced, as well as on the new approach to human genetics, but emphasizes the responsibility of such an organization as the Carnegie Institution for preserving intact some of the more important threads of fundamental scientific research, now almost completely stopped all over the world. With regard to defence activities, nearly all the research in the Department of Terrestrial Magnetism was on Government problems, and the number of men employed in that laboratory had been more than doubled. Important work was also proceeding in the Geophysical Laboratory, the Mount Wilson Observatory and the Nutrition Laboratory.