

certain knowledge with reference to the variable parts of the run-off in each case has been obtained.

(3) A reasonably accurate numerical expression has been obtained from the effects of barometric pressures on the elevation of the water surface at the Marquette Station on Lake Superior, and constants enabling one to compute the hourly or daily effect of a wind of any velocity and direction upon the water-surface at the same station.

(4) The knowledge gained in (1) and (2) has been applied to the estimation of evaporation losses from land surfaces, and the combined effects upon stream flow.

Space does not permit any detailed description of the investigation or of the evaporation formula. They have, however, involved an immense amount of work and many thousands of calculations.

In applying his conclusions to stream flow in the

second part of the treatise, the author assumes that the evaporation from a land surface follows the same laws as, and bears a constant ratio to, the evaporation from a free open water surface in each watershed. In his expression for the 'normal' flow of any stream there appear eleven terms, one of which is termed the 'constant' part of the flow, and the remaining ten terms functions of the rainfall in varying periods extending to 257 days preceding the day of the observation. The coefficients for these terms have been determined and the results tested against actual stream flow records.

The impression gained by a study of this work is that the author has unquestionably advanced the study of the laws of evaporation from water surfaces, but that in its application to stream flow he has devised a process on assumptions which are not fully justified by results. H. L.

### The Origin of the Irish Fauna and Flora.

WHILE the flora and fauna of Ireland are essentially those of Great Britain, differing chiefly in the absence of Germanic species, the occurrence of the so-called Lusitanian and American elements has made Ireland an area of special interest to biologists and geologists who have sought to trace the history and origin of its floral and faunal life. The Lusitanian flora, as is well known, has its continental centre in the Iberian Peninsula, while a correspondingly small faunal group, comprising no large animals, has a somewhat similar distribution. In Ireland most of these Lusitanian plants and animals are found in the south and south-west, although some extend northwards. The American element, even smaller than the Lusitanian, is separated from its main area of distribution by the Atlantic Ocean. Reference may be made also to an Arctic-Alpine element which, although better represented in Britain, is fairly widely distributed in Ireland. The absence of certain British species and the presence of Lusitanian, American, and Arctic-Alpine species are some of the outstanding facts which any complete theory of the origin of the Irish fauna and flora must explain.

So long ago as 1846, Edward Forbes, in a paper dealing with the geographical distribution of plants and animals in the British Isles, was among the first to inquire into the geological changes affecting their area, and since then biologists have repeatedly attacked the problem from different angles. In seeking a solution to the problem it has always been recognised that the most important factor was the intervention of the glacial period, but the effects of the changes thus brought about have been very variously estimated. Some have advocated complete extermination of the Irish fauna and flora; others have believed in a considerable survival dating from Miocene times. In these discussions the voice of the geologist has not been sufficiently heard, and biologists will welcome, therefore, the authoritative views recently expressed by Prof. J. Kaye Charlesworth.<sup>1</sup> The author describes the complete burial of Ireland beneath the Pleistocene ice-sheet at the maximum of glaciation as an indisputable fact, and the possibility of survival during glacial times of even the smallest part of the Irish fauna and flora as we know it to-day must be definitely excluded from our calculations.

Survival in some unknown southern or western asylum beyond the limits of the ice has been, however, frequently postulated and commonly accepted among biologists. This question is largely a geological one, and Prof. Charlesworth enters into it fully, examining critically the evidence regarding changes of sea-level

during the Pleistocene, and the climatic conditions of the ice-free strip, if any such existed. The problem of the glacial sea-level is complicated, but obviously of fundamental importance. When glacial conditions set in, Ireland was an island with a coast line very similar in position and level to that of the present time. During glacial times the sea-level did not remain constant, otherwise all possibility of survival could be "most categorically denied". From all the available evidence, too detailed to summarise, the conclusion is reached that during the glacial period the sea-level around the Irish coasts was lowered by about 50 fathoms. To the south of Ireland this line encloses an extensive area which might provide a place of refuge, but taking the most favourable view for survival, Prof. Charlesworth thinks that probably only arctic and boreal species persisted on the southern ice-free strip. To the west there was no ice-free area.

Immigration of the present Irish flora and fauna took place, therefore, subsequent to maximum glaciation. The view is held that a considerable fauna and flora, including Lusitanian species, reached Ireland during the "Aurignean Oscillation" when the ice-sheet withdrew from the southern half of the island. Prof. Charlesworth leaves to biologists to decide what species may have survived the ensuing Early Magdalenian Glaciation when the ice readvanced to the line of the 'South Irish End-moraine' running from Wexford to the mouth of the Shannon. For immigration into Ireland a post-glacial land connexion with Great Britain existed, but the connexion was never complete. The 'bridge' between Ireland and the Scottish mainland was severed by the Sound of Jura, while the more southerly 'bridge' between Ireland and Wales was broken by a narrow strait or wide river west of Anglesey. Over this broken drift plain the greater part of the Irish fauna and flora seems to have entered, and clearly some accidental dispersal would be necessary to effect the crossings. The later submergence during the "Atlantic Period" prevented further immigration, and those forms which continued to extend their range westwards in Britain after that date could enter Ireland, if they did so at all, only by chance dispersal.

Prof. Charlesworth's exposition of the geological factors which must be taken into account is of the greatest importance to biologists and provides a much safer starting-ground than any hitherto available for tracing the history of Irish plant and animal life.

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<sup>1</sup> "Some Geological Observations on the Origin of the Irish Fauna and Flora." By Prof. J. Kaye Charlesworth. *Proc. Roy. Irish Acad.*, 39B, pp. 358-390; 1930.