

lous caution. Of its numerous valuable and novel features, two claim particular notice, namely, the chapters on the history of cultivated and introduced plants; and the further development of Humboldt's 'Arithmetice Botanices,' by taking into account the sums of temperatures as well as the maxima, minima, and means, in determining the amount of heat required to satisfy all the conditions of a plant's life, at the various periods of its existence, and especially the maturation of its seeds.

Of Mr. Wallace's great work 'The Geographical Distribution of Animals,' I cannot speak with sufficient knowledge of the subject, and can only appreciate and echo the high praises accorded to it by zoologists, for its scientific treatment of a vast subject.

The 'Géographie Botanique' was followed by the late Dr. Grisebach's 'Die Vegetation der Erde,'¹ which contains an admirable summary of the vegetation of the different regions of the globe as limited by their physical features, divested of all theoretical considerations.

For the largest treatment in outline of the whole subject of distribution, I must refer to the chapters of Darwin's 'Origin of Species,' which are devoted to it.

In reference to these and other works, very able and instructive discussions of the principles of geographical distribution are to be found in the presidential addresses delivered before the Linnean Society, in 1869, 1870, and 1872, by the veteran botanist, G. Bentham.

With Mr. Wallace's 'Island Life' I must conclude this notice, and very fittingly, for besides presenting an admirable account of the origin and migrations of animals and vegetables in oceanic and continental islands, it contains a complete and comprehensive analysis of those past and present conditions of the globe, astronomical, geological, geographical, and biological, which have been the earlier and later directors and controllers of the ever-warring forces of organic nature. In this work Mr. Wallace independently advocates the view of the northern origin of both the faunas and floras of the world.

I conclude with the hope that I have made the subject of the distribution of organic life on the globe interesting to you as geographers, by showing on the one hand how much it owes its advance to the observations made and materials collected by geographical explorers, and on the other how greatly the student of distribution has, by the use he has made of these observations and materials, advanced the science of physical geography.

The following Papers were read:—

1. *The Equipment of Exploring Expeditions Now and Fifty Years Ago.*
By FRANCIS GALTON, F.R.S.

The equipment of a modern exploring expedition differs in many respects now from what it was in or about the year 1830, with the general result of increased efficiency and rapidity of execution. The standard instruments—namely, the theodolite, the sextant, the chronometer, and the azimuth compass—have not received any great improvements in the interval, and the best of those made in 1830 would be valued now. But they are made more handy and portable than they were, and at much lower cost for equal degrees of excellence. The modern water-tight cover, with the keyless winding arrangement of travellers' watches, is a great boon to them. The mercurial horizon, without which the sextant on land is almost useless for astronomical purposes, has been transformed from a lumbering trough shielded from the wind by a heavy glazed screen, which was difficult to fill and did not admit of the observation of low angles, into a very compact contrivance by Captain George, which is filled by tilting, and is sheltered from the

¹ Published in 1872. Translated into French under the title of *La Végétation du Globe*, by P. de Tchihachef, Paris, 1875.

wind by a piece of glass floating on the mercury. The liability to errors introduced by this arrangement is much smaller than might have been expected, and travellers speak highly of its merits. The appliances for measuring elevation above the sea-level have been greatly improved. The old method was to carry a mountain barometer, which, from the weight of the mercury and the fragility of the glass that contained it, was rarely carried far without breakage. Since then the aneroid has been invented, and the appliances connected with the boiling-point thermometer have been greatly improved. A traveller provided with these very portable instruments can use the aneroid for everyday purposes, checking its change of index error from time to time by boiling-point observations. Even the mercurial barometer has been rendered a comparatively portable instrument. The tubes are packed empty, and they are filled when required by Captain George's method, which in moderately careful hands is found to give good results. The enclosed thermometer for deep-sea observations is a recently invented instrument absolutely essential to accuracy.

The art of exploring ocean-depths and performing what has been called Thallassography, has been immensely improved, owing to the requirements of submarine telegraphy and of such scientific expeditions as that of the *Challenger*. Sir W. Thomson's method of sounding at the depth of many fathoms without checking the ship's course is in full use, but Dr. Siemens' bathometer has not yet been made practically serviceable.

The accuracy of thermometric graduation has been greatly increased by the verifications afforded by the Kew Observatory, which is the child of the British Association, established, and for a long time maintained, by a yearly grant from its funds, but now supported by the endowment of Mr. Gassiot. The errors in thermometers occasionally furnished even by the best makers in 1830, were such as would not be tolerated now. The verifications of Kew are extended to other instruments, and the influence of the Observatory for good is firmly established and appears to be yearly increasing. Of the other appliances for geographical travellers—such as scales for plotting, metal pens which were invented since 1830, and that admirable recent contrivance the stylographic pen—it is unnecessary to speak in detail. The binocular opera-glass is, practically speaking, a new instrument, and its merits as a night-glass were first found out long after 1830. The lunar tables of the 'Nautical Almanack' have been greatly improved of late years, for in 1830 their predictions of the place of the moon could not have been trusted as they now are for delicate determinations of longitude. Lastly, the means of instruction in the use of geographical instruments is at length afforded by the Geographical Society, who have erected a small observatory on the roof of their premises, where instruction is given on moderate terms to intending travellers.

The modern equipment of travellers as regards dress has been greatly improved by the general use of flannel, which is a most important preservative of health, but was neglected half a century ago. Thus, at much more recent times than 1830, the hardy Swiss guides had a horror of what they called a *coup-d'air*, or a chill on the mountain-top, when they were hot and perspiring; and no wonder, as they then all wore linen shirts next the skin. The modern loose form of dress, the shooting boots and easy overcoat, are a vast improvement on the pinched costumes of 1830. The derivation of the word *paletôt* conveys a history. The first warm and convenient coats used in England were reproductions long subsequent to 1830 of those used by sailors in rough weather under the name of 'pilot coats' (and were sometimes, for the sake of shortness, called 'p. coats' or 'peacoats'). They quickly became the fashion, were copied and made more elegantly by the French, who adapted our name of 'pilot coat' to their own pronunciation of *paletôt*, and so we received it back from them. India-rubber and gutta-percha adaptations to articles of dress and manufactures generally date from a little subsequent to 1830; they are invaluable for many purposes to exploring expeditions. The form of tent has been greatly improved. Portable mackintosh and other coats are comparatively recent contrivances, and have done good service. Lucifer-matches had been invented, but only very recently, in 1830.

The equipment of a travelling party as regards packsaddles has been improved,

chiefly through Australian experiences, where, moreover, the camel has been introduced as a beast of burden, with more success than the tamed elephant in Africa. The art of sledge-travelling has been vastly improved by the skilful cutting down of all superfluous weight, enabling travellers to drag more food, and so to be absent from their depôts for a larger number of days.

As regards food, the tinned meats, compressed vegetables, and condensed milk, which are invaluable during the first days of travel before the expedition has settled into regular ways, are all late inventions, and the merits of lime-juice are now far better understood than they were fifty years ago.

The *personnel* of a travelling party is decidedly improved. Whatever may be the state of the physique of the lower orders of the population, there can be no doubt that the upper orders are physically better developed than they were. They are, as I have good reason to believe, in the absence of direct measurements, taller; they achieve greater feats in running, leaping, walking, and other athletic performances than their grandfathers did. They lead healthier lives from the discontinuance of the heavy eating and hard drinking of old days, from the better aired sleeping rooms, the existence of proper means of washing, and the seaside or Continental summer vacation.

The greatest benefit of all to travellers is the modern rapidity and ease with which distant parts of the world are now reached. In 1830 it required 70 days sailing from England to reach the Cape of Good Hope, 120 days (in the S.W. monsoon) to reach Bombay, and 130 days to Sydney. It was 40 days' sail to New York, 42 to Jamaica, 56 to Rio, and 110 to Valparaiso. The length of time that the post now takes from London to these places is as follows: Cape Town 21 days, Bombay 18 days, Sydney 43 days, New York 10 days, Jamaica 18 days, Rio 21 days, Valparaiso 39 days; the average increase of speed being more than threefold. There is scarcely any important part of the world that cannot now be reached in two months from London; even the Antipodes are only six weeks' journey. This facility of communication is accompanied by a corresponding spread of commerce, and travellers can now easily refit themselves at distant points. It has recently occurred to the Geographical Society to have had to meet bills drawn upon her Majesty's consul at Zanzibar by a traveller in their employ, for which he had been furnished with goods by Arab traders at Nyangwé on the Upper Congo, as well as at places in Central Africa which had never before been visited by a white man.

2. *Isochronic Postal Charts.* By FRANCIS GALTON, F.R.S.

By 'isochronic' postal charts I mean charts that show the distances attained in all directions from the same starting point, by the post, 'in equal times.' Let us view in imagination the stream of travellers who leave London simultaneously and go as quickly as they can to their destinations, starting by the postal routes. Some of the travellers will be seen to leave the main lines at each successive halting-place, and to branch to the right and to the left, perhaps repeatedly and by various conveyances, before their journey is over. They may reach the same goal by different routes, though not at the same moment. In the meantime the travellers on the main tracks are swiftly moving ahead. At length every part of the world is reached. The course of the stream of travellers may be likened to the spreading of the tide as it advances over broad sands. The rising waters run quickly along certain channels. These diverge, subdivide, interlace, and join. After a little more time only a few isolated patches of dry shore can be seen, at last the whole surface is overspread by the water. In the maps I exhibit, I have endeavoured to represent this appearance upon all the postal routes from London. In accordance with the definition of 'isochronic' given above, I am obliged to suppose that the mails have been despatched simultaneously to all parts, and I show by bands of different colours where the travellers would be at different periods. All places within ten days' journey of London are coloured green, those between ten and twenty are orange, between twenty and thirty they are red, between thirty and forty they are blue, and those beyond forty are brown.