theorems for elliptic functions. Many years later, Jacobi referred to the day on which a copy of Fagnano's works reached Euler as "the birthday of elliptic functions". Landen, in his "Mathematical Lucubrations" (1755) studied transformations of integrals, showing considerable ingenuity in obtaining forms convenient for calculation. This aspect was developed later by Legendre, Gauss and Ivory. Prof. Watson mentioned, in passing, that, in his opinion, mathematicians of the eighteenth century handled the technique of the calculus more skilfully than the technique of analytical geometry.

After this pioneer work, development took place on two very different lines. Legendre developed the elaborate, but unfruitful calculus of integrating expressions giving elliptic arcs, whilst thirty years later Abel and Jacobi developed the vastly more important concept of inverting such integrals, thus founding the theory of doubly periodic functions. One of time's revenges lies here. The first mention of this concept of inversion is in a manuscript by Gauss dated January 8, 1797. Had Legendre known of this, he would never have given the last part of his life to the futile labour of his "Traité des fonctions elliptiques". Yet Gauss's failure to announce his result was directly due to his treatment at the hands of French mathematicians when his memoir on arithmetical numbers was refused publication by the French Academy. After their humiliating refusal to publish this work, Gauss was loath to take any steps to publish during his own lifetime.

Prof. Watson mentioned some recent approximate formulæ for the perimeter of an ellipse, due to Peano (1887)—a mathematician usually associated with very different studies—and Ramanujan (1914). In connexion with his address an unusually complete exhibition of books on elliptic functions, arranged chronologically, had been compiled by Prof. Neville.

The discussion on "The Study of Statistics in a School Course" was opened by Mr. F. Sandon, headmaster of Plymouth Grammar School, who presented the unpopular view that the subject could have no place in the normal course. He suggested that the capabilities of pupils are so various and the intrinsic difficulties of the subject so real that little value

would result. Few teachers appear to know much of the subject. Statistical principles can be applied to modify some topics in the arithmetic course, such as the teaching of averages and graphs of statistics, but work beyond this, such as probability or correlation, is too difficult or laborious. Mr. Tuckey of Charterhouse and Mr. Wright of Winchester gave evidence flatly contradicting this. With an average middle school form, a course of two hours a week has proved possible and profitable at Charterhouse. Frequency curves, probability, dispersion and correlation have been studied with some seriousness. At Winchester, rather abler boys with no examination in prospect have covered a systematic textbook course as far as Spearman's "Foot-Rule" for measuring correlation. The balance of opinion of the meeting appeared to favour testing these opinions as to the possibility of teaching statistics in schools.

Other papers discussed various topics. Dr. Smart of Cambridge traced the history and importance of the precession of the equinoxes. Dealing with the importance of accuracy in observation, he mentioned the recent discovery of the work of the Rev. John Hornsby, an eighteenth century Oxford astronomer. From Hornsby's observations it is possible to obtain the data showing the motion of the perihelion of Mercury—a phenomenon that was not satisfactorily explained until the present century. Work in school was dealt with by several teachers. Mr. Boon of Dulwich pleaded for more use of side-tracks such as history and puzzles in elementary mathematics. Mr. Robson of Marlborough showed the possibilities of parametric representation in the specialist course. A keen discussion followed Mr. Siddons's paper on "Learning Theorems in Geometry". Mr. Siddons suggested that learning theorems is not valuable until pupils have some skill in solving riders. Mr. Piggott of Dartmouth put forward a more real method of teaching relative velocity than that current in textbooks. The device of 'reversing a velocity' was shown to be quite unnecessary. Finally, the Rev. D. B. Eperson of Sherborne concluded a most successful meeting with a diverting account of Lewis Carroll's work as mathematician.

Annual Conference of the Geographical Association

THE annual conference of the Geographical Association was held at the London School of Economics on January 4-6, and at the Imperial Institute, South Kensington, on January 7. About five hundred members took part, provincial and Scottish branches being particularly well represented.

The retiring president, Dr. H. R. Mill, chose as the title for his presidential address "An Approach to Geography". In fluent and easy language, yet with a precision too often absent from generalisations, he traced the progress of the modern concept of scientific geography. He emphasised the steady conquest by man of so many of the natural factors of his environment and the evolution of the world of to-day, which may thus be free and open to the movements of mankind. But man, in conquering the natural barriers, has erected in their stead artificial barriers in the form of frontiers with their tariff walls and innumerable other restrictions. Thus the geographer cannot ignore the new, though artificial, factors of the environment and his work must interlock with that of the economist. At the

same time, the problem is complicated by the fact that geographical factors are becoming more and more important in that, with the world improvement of transport and communications, it no longer pays a country to attempt the production of a commodity for which it is geographically unsuited.

This function of the geographer in helping to provide solutions for the complicated problems of the present day was further emphasised by Sir John Russell in his lecture on "Modern Changes in the Sources of our Food Supplies". One of the speakers at the annual dinner referred to geography as the 'most human' of all the sciences and to the appropriateness of meeting in the School of Economics, which was represented at the dinner by its director, Sir William Beveridge. The benefits to be derived from collaboration with allied sciences was further emphasised by a joint meeting with the Le Play Society, when an account of studies in Yugoslavia—the result of party visits led by himself and Dr. L. D. Stamp—was given by Mr. Arthur Davies.

The Association extended its welcome to Col.

Kenneth Mason, recently appointed professor of geography in the University of Oxford, who lectured on the exploration of the Himalaya, and to Lord Meston, whose first-hand account of contrasts in the Ganges basin threw many delightful sidelights on Indian geography.

The revival of interest in the land of Britain and its uses must inevitably be a feature of the next few years and the Association was given an account of the work of the Welsh Plant Breeding Station, Aberystwyth, in Prof. R. G. Stapledon's lecture on the improvement of hill grazings. A brief account was given of the progress also of the Land Utilisation Survey, now nearing completion.

Amongst the many meetings arranged for teachers, special interest was attached to the discussion of a model First Certificate examination paper drawn up by the Standing Committee of Secondary School Teachers. No new features not already commonly used in this examination were found suitable for inclusion, and suggestions made by some teachers present were nearly all negatived by others. Though taking little part in the discussion, a number of examiners were present and were doubtless relieved to find the meeting expressing the opinion that papers actually set by various examining bodies in recent years compare very favourably with the paper suggested by the Committee. Many teachers were clearly brought to realise the extreme difficulty of setting a paper to be answered by ten thousand candidates prepared by a thousand different teachers.

L. DUDLEY STAMP.

Calendar of Nature Topics

St. Hilary's Day. The depth of winter

January 14.—Although in the northern hemisphere the shortest day and least amount of insolation occur about December 21, the temperature of the air is maintained by the heat stored in earth and sea, and as this heat is given up, the average temperature continues to fall for nearly a month after the shortest day. This is expressed in the proverb:

"As the day lengthens,
So the cold strengthens."

The turn of the season is associated with St. Hilary's day in England and with St. Maur's day (January 15) in France. According to the smoothed ninety year averages at Greenwich, the coldest days of the year are January 12-14, all of which have the same mean temperature. The vagaries of our climate are, however, so great that in any one year the coldest day may fall on any date from mid-November to mid-March.

Winter Congregations of Birds

During January, Gilbert White noted the congregating of several species of British birds—in the order of their observation, skylarks, snow-buntings and chaffinches. He might have added, as equally characteristic of the season, fieldfares, redwings and mistle-thrushes, for the flocking together of the individuals of a species during the off-season when sex is at its lowest is a common occurrence. Of all the congregations, those of the chaffinch intrigued him most, first because the vast flocks which he saw contained many more birds than could be hatched in one neighbourhood, and secondly because the flocks seemed to be almost all hens. On the latter point he had been misled to some extent by Linnæus

who, thinking that "before winter all the hen chaffinches migrate through Holland into Italy", leaving the cocks behind, named the species *Fringilla cœlebs*. Although there is no such independent migration, it is true that there is a tendency for chaffinches to group in flocks in which one sex predominates, but equally mixed flocks are common enough. As regards the excessive numbers in the winter flocks, the explanation is that while we retain our native stock—for our British-bred birds do not seem to migrate—there are added to their numbers, immigrants from northern and central Europe which remain in Britain from about November until May, and birds of passage which make a temporary sojourn in Great Britain during their progress towards, and return from, south-western Europe.

Movements of Winter Flocks of Birds

It is generally stated that the winter flocks of chaffinches in Britain are nomadic, wandering from one area to another in search of food, and although it is certain that such as the great immigrant flocks of wood-pigeons move over the country from one feeding ground to another as food supplies become exhausted, an American experiment suggests that more has to be learned about the detailed movement of the winter congregations. Crowned sparrows (*Zonotrichia*), on their winter migration, arrive in late September on the campus at Stanford University, California, and leave on their northward migration in late April or early May. A combination of ringing, trapping, and staining the feathers with a distinctive oil colour dissolved in carbon tetrachloride, so that the members of a particular flock could be recognised in the field, led to some interesting results (John B. Price, *Condor*, 1931, p. 238). In the first place, individual birds, after their summer migration to the breeding quarters, which range from British Columbia to Alaska, frequently return to winter in the same district and are usually recaptured even in the same trap. In the winter of 1927-28, 197 golden-crowned sparrows (*Z. coronata*) were ringed at Stanford, and in the following winter after a lengthy migration 28 per cent were re-captured there, and many more may have returned which were not trapped. In 1928-29, 120 golden-crowns were re-captured which had been captured (ringed or recovered) at Stanford the previous year. Of these, 96 were taken by the original trap and only 24 were re-captured exclusively at other traps, although the traps were quite close together. Here is an indication not only of a fine sense of locality, but also of a certain flock association which remains constant in successive winters in spite of the intervening break-up of the breeding season.

A second remarkable discovery, revealed by the trapping of ringed birds and confirmed by the movements of artificially coloured birds, a standard colour having been adopted for each flock, was that there was practically no interchange of individuals between flocks. Although the two traps concerned with two distinct flocks were but 100 yards apart, only one case of the crossing over of an individual occurred. Further, none of the stained golden-crowned sparrows was seen 600 yards from the staining trap and most were observed within 400 yards of it. It would seem that if territory dominates the breeding pair during spring and summer, it dominates the flock and not the individual during the winter, to such a degree that each definite flock has its own almost exclusive range of about 15-20 acres.