method. On one hand, it is argued that it is not sufficient for horticultural standardisation, which has to meet stringent modern commercial requirements, that the scion should be a clone, so that the produce of one variety, whilst plucked from the branches of one and the same plant, may be nourished on those branches through the roots of countless different varieties. On the other hand, it is argued by the practical man, in the light of horticultural experience, that a Cox's Orange scion gives a Cox's Orange apple whatever the root system may be, and Prof. Ravaz's experience with vines seems to endorse this conclusion.

Whilst it is agreed that certain stocks, 'dwarfing' stock, modify the habit of the tree in that they cause dwarfed growth and early bearing, there is no evidence that the quality of the scion fruit is modified; and provided that ordinary care to select vigorous seedlings is shown, there seems little doubt that uniform orchards of the scions are obtained—uniform because the stock is not

limiting appreciably the natural vigorous full growth of the scion.

Much work still remains to be done upon this interesting problem; the interchange of comment and criticism at the congress is a good augury for the report of progress at a later congress, whilst some of the contributions show the interesting range of the problems. Thus, Prof. N. F. Hansen (Dakota, U.S.A.), Dr. L. Filewicz (Poland), and Dr. J. Smolak (Czechoslovakia) joined in a symposium upon fruit culture problems in regions where frost damage is frequent and severe. In the course of this discussion, Dr. Filewicz pointed out that certain apple trees which are susceptible to frost in central Poland resist the winter after top-grafting with a more hardy variety. Dr. Filewicz described some very remarkable experiments in keeping frost-injured trees alive and bearing by making new unions between shoots thrown up from the roots and buds on higher branches still capable of growth.

An Elizabethan Colony of Craftsmen.

By Dr. E. F. ARMSTRONG, F.R.S.

THOSE who walk the fells of the Lake District will not have failed to notice the abandoned copper workings which scar the hillsides in many places, notably at Manesty and elsewhere in Borrowdale, near Stair and at Goldscope in the adjacent Newlands Valley, at Grasmere, in the Vale of St. John, and in other localities. Whilst it is common knowledge that these represent ancient mines dating from the time of Elizabeth, only the few are aware how unique and interesting a historical story is attached to these visible relics of bygone days. It has relation to the formidable enterprise of bringing from Germany to the Keswick dales a little colony of workmen and experts in the mining and smelting of copper. It needs very little imagination and knowledge of the existing conditions in England at that time to picture the dales as then, surely very remote from medieval civilisation, particularly when it is remembered that the Lord Warden was watching the fords to hold back the Armstrongs and the Grahams but a few miles north of where the craftsmen in Borrowdale were to be engaged in their peaceful activities.

Though the enterprise was in the end a business failure, it left its impress on the district in numerous ways, as witnessed by many mixed marriages with the dalesfolk, by German words absorbed into the local dialect, by place names: the details of all these afford a fascinating study in local history. Far more important, however, in its ultimate effect on the prosperity and future of the district, must have been the spending there during the life of the venture of upwards of £100,000, and that at a time when money was worth several times what it is to-day. Although many of the fortunes made locally were lost for King Charles, this undoubtedly led to a development of the Lake country, both then and afterwards, quite out of proportion to its inaccessible and wild character, as well as to the provision

and maintenance of routes and roads to Newcastle via Barnard Castle and to the south in advance of the times. Leland, whose "Itinerary" was written about the year 1545, calls Keswick a poor little market town. Elsewhere we read of the Lake country being almost *terra incognita* until the publication of the letters of Gray, the poet. It is a satisfaction to those who are fighting for the preservation of the natural beauty of the district to-day to remember that Gray's later letters, especially those from the Lakes in 1769, show before those of most others the rising sense of the picturesque in literature.

The known facts relating to the settlement compiled from local sources have been supplemented in an altogether unexpected manner by the discovery at Augsburg of the original account books of the German firm, Haug, Langnauer and Co., including twelve volumes of manuscript which are the actual journals written at Keswick and sent first to Hans Loner, the agent in London, and by him, after some added pages of balancing, to Germany. These have been rendered available by W. G. Collingwood in 1912 in a publication of the Cumberland and Westmorland Antiquarian and Archaeological Society.

The value and interest of this find is very great when it is remembered that the earliest known English diaries come from the late sixteenth century and that some of them grew out of a punctilious habit of keeping accounts. More than the usual bald facts of the financial operations began to be added, and the entries became amplified, so that one finds in them as here the ancient day spread out before us in considerable detail.

The Company or Society of Mines Royal was founded in 1564, when an indenture was made between the Queen on one part and Thomas Thurland and Daniel Hechstetter on the other, to search, dig, try, roast, and melt all manner of mines and 'ures' of gold, silver, copper, and quicksilver in a number

of counties. The Queen was to have one-tenth of the precious metals and one-twentieth or 2s. per cwt. on the copper.

Hechstetter proceeded to form a company with a number of prominent shareholders, including Lords Burghley, Pembroke, Leicester, and Mountjoy. In 1566-67 parties of German workmen were brought from Schwatz to Keswick. A rich mine was very soon found at Newlands, on the manor of the Earl of Northumberland, in 1566—the Germans called this "Gottesgab", a name which locally became Goldscope. The Earl stopped the working after a time, claiming the sole right to the minerals. His suit against the Queen went before all the judges and barons of the Exchequer in 1568, when it was decided by a majority that as there was more gold and silver than copper and lead in these mines, the Queen was within her rights in claiming them. A strange miscarriage of justice this, and an early example of faulty analysis (!), particularly as it remained the leading case regarding Royal rights in mines until the time of William III.

Hechstetter's accounts were made up seven times a year; they enable us to picture almost every happening in the life of the colony. For example, in 1569 we find complete accounts, amounting in all to £21 9s., for building the men's bathroom. Whereas the company bore the expenses and outlay, the men agreed to repay this afterwards out of club money and fines. At that time, apparently, the use of baths was frequent in Germany, both in private houses and in public baths: it is stated that the hot bath was used as an antidote to immoderate drinking. Wine for the colony was bought by the tun or cask and resold to the men at a price which made no profit; there are entries of its purchase at Newcastle, at Kendal, and at Cockermouth, in the last instance from Henry Fletcher, the well-known merchant who had entertained Mary Queen of Scots on her landing at Workington a few months earlier (May 15, 1568), when she fled to England after the defeat of her army at Glasgow.

The smelt houses were begun in the summer of 1566 at Brigham, on the Grete, half a mile from Keswick. Within a year, Thurland confessed that they were "more chargeable than he had imagined", an experience which has been repeated by most inventors of new processes down to this day. Hechstetter persevered, however, and did well to create, in a country so barren of facilities, a cluster of workshops and machinery so famous as to make Camden at the end of the century write "not without admiration to those that behold it". Alas! The progress of actual smelting was accompanied by the devastation of the woods far and wide, local labour being used for this purpose, though skilled charcoal burners were imported from the Midlands. An attempt was made to form charcoal-burning stations in Ireland at a time when the opposition of the Earl of Northumberland made local supplies difficult.

There are items in the accounts of 1569 for the carriage of sea or stone coal from Cockermouth and from Workington, and a payment of 1s. 4d. for a man to watch for several nights over the coal at the

smelting house for fear of it burning; this seems to have been their first practical introduction to mineral coal. One Anthony Dediman was promised £20 if he found coal mines near Keswick; there is an entry of £4 in hand and 3s. 4d. earnest money. No coal was found, but he spent a good deal in this fruitless search.

Although the first royal charter to dig coal in the Castle Fields was granted in 1239 by Henry III. to the freemen of Newcastle, and the coal trade became an important branch of commerce within fifty years, apparently it was not in general use in provincial towns until the reign of Charles I. These journals must be the first records of coal being worked in Cumberland, for it was not until a hundred years later that Whitehaven became a busy export centre, chiefly to Ireland and Scotland.

The mines, workshops, and houses were lit with tallow candles, but in November 1570 there is mention of a sample of train oil which soon afterwards was used in the mines. Although, according to Hakluyt, whale fishing began somewhat later than this date, it is known that a number of English ships were fishing off Iceland about this time. This is probably one of the first uses of the oil in England.

The original business of Haug and Co. was drapery, and at first they tried to sell silk and satin and other costly stuffs at Keswick, disposing of more than £400 worth.

The mines were worked to some extent by what is called 'tributing'; the miner chose his own place, hewed at his own pleasure, and was paid a percentage on the value of the ore he got. He paid for his own candles and tools. Apparently the earnings by this method were very uneven. The system survived to the end of the period of copper-mining at Coniston.

The details of one of Hechstetter's journeys with three others from Augsburg to London show how he travelled by cart from Speir to Mainz, hired a boat to Cologne, then a covered carriage to Antwerp, thence to Calais, how is not stated; across the water to Dover, which cost £2 6s., horses to Gravesend, and from thence to London by boat. The customs at Dover extracted 16s. duty! The same paragraph contains the item "a poor German in charity 3s."

In spite of the energy of Hechstetter and his associates, the enterprise did not prosper financially; we are told that, notwithstanding very considerable quantities of copper had been won, the difficulty of finding a market was accentuated in 1571 owing to the depression of trade in England during that year. There is a long and somewhat despairing letter from Langnauer in Augsburg to Loner in London, who in consequence approached the Queen, probably through Leicester, begging her very materially to increase the amount of copper ordered from the company.

A little later fresh impulse was given to the business by the addition of coppersmith's work, that is, the making of kettles, pots, and pans, for which skilled men were again imported from Germany. An artistic craft was thus very early introduced

into the dales, which to-day the school of industrial art is perpetuating.

In 1576, Loner left the business, but Hechstetter struggled on for a few years: the company was reconstructed by Thomas Smyth in 1580. His enterprise prospered for some years, mines being opened also in Cornwall and South Wales, but by 1597 the Keswick works were in difficulties again. A little later, in 1600, an inquiry into the condition of the northern mines showed that in thirty-six years, after paying £4500 to the Queen, £68,103 had been made by the sale of metal, and the expenses had been £104,700 plus a capital outlay of £27,000. Nearly all the money, found and lost by Augsburg and London merchants, had been lavished in the dales.

The smelt houses were destroyed at the Civil Wars, probably in 1648, and many of the miners slain.

Certain points in this very slight sketch of the colony in the dales are outstanding; one, the effect of the intermarriage of the Germans with the dales-folk in promoting some of the energy and intelligence for which the 'old stocks' were remarkable, which together with the then large sums of money spent locally by the enterprise have had a far-reaching effect on its subsequent prosperity and development; the other, the close parallelism between the trials and tribulations, both technical and financial, in starting a new industry three hundred and fifty years ago and to-day. Very little profit in this respect seems to have been gained by experience; indeed, it appears axiomatic that the first venturers will not reap material rewards. Then, as now, we cannot withhold admiration from the German craftsmen for their willingness to try new ideas, new methods, with scientific thoroughness and exactitude.

Obituary.

PROF. H. H. TURNER, F.R.S.

THE death of Prof. H. H. Turner occurred at Stockholm, where he was attending the meetings of the International Union of Geodesy and Geophysics. Just before the afternoon meeting on Saturday, Aug. 16, he fell forward on the table. His colleagues at first thought he had merely fainted, but the doctor who was called found that he had a severe attack of cerebral hæmorrhage and had him removed to the hospital. His wife was informed and she and her daughter went at once to Stockholm by aeroplane. He died on Wednesday, Aug. 20, without recovering consciousness.

Herbert Hall Turner was born at Leeds in 1861, and went to the Leeds Modern School and then to Clifton College. He obtained a Major Scholarship at Trinity College, Cambridge, was Second Wrangler in 1882 and second Smith's Prizeman in the following year. He became Chief Assistant at the Royal Observatory, Greenwich, in 1884, shortly before his election to a fellowship at Trinity. He soon became interested in the problems of fundamental astronomy and made researches on the $R-D$ discordance of the Greenwich transit circle. He elucidated but did not find a complete explanation of this still unsolved problem of the persistent difference between the zenith distances of stars from observations taken by reflection from mercury or directly. It is still in doubt to what extent this is due to flexure of the instrument, the differences of temperature in the observing room from that outside, and other instrumental causes. Turner made series of observations of the temperature in different parts of the room, and varied the conditions in which the observations were taken, taking the direct observation before that made by reflection.

A leading part was taken by Turner in a determination of the longitude of Montreal. This was determined in three links: Greenwich-Waterville, Waterville-Canso, Canso-Montreal. The difference of longitude Montreal-Washington being already

known, the longitude of Washington was thus determined. The result obtained by this complicated series of connexions agreed closely with the direct determination found in recent years with the assistance of wireless signals. The difference of longitude Paris-Greenwich was twice determined conjointly with French astronomers. Here the results were not accordant, as in both series the French obtained a larger value than the English observers. Accordant results were not obtained until 1902.

Turner took part in a number of eclipse observations, and, like other astronomers, suffered from the vicissitudes of weather. At one of these expeditions, a brother-astronomer was seriously ill with fever. With characteristic kindness, Turner deliberately read the thermometer wrongly to the patient, and so cheered him that his temperature fell before the end of the visit. For the eclipse of 1896, in Japan, Turner introduced the use of the *cœlost*at. M. Lippmann had pointed out that a mirror turning on an axis in its own plane at half the speed of the earth's rotation and pointing to the pole gave a stationary image of the entire field. Turner realised the great convenience of this for photography of the sun at eclipses, and, with his friend Dr. Common, designed instruments which have served English observers in many subsequent eclipses. The weather was unfavourable in Japan in 1896, but Christie and Turner had good fortune in India in 1898, Newall and Turner in Algiers in 1900, and Turner and Bellamy in Egypt in 1905. He went to Paris for the eclipse of 1912 as a spectator, as the duration of totality was too short for serious observation; and at the eclipse which passed over England in 1927 he and Dr. Knox Shaw had only partially favourable weather at Southport.

Turner entered heartily into the scheme for the International Photographic Map of the sky inaugurated at Paris in the late eighties. Christie obtained one of the standard astrographic telescopes made by Sir Howard Grubb for Greenwich, Gill one for the Cape, Pritchard for the University