of new allotments, aiming at establishing another 500,000. Many of the existing gardens and allotments are not, however, fully used, and it is desirable to improve them as speedily as possible. Technical advice is now available in every county. There is, however, a real danger of considerable waste of seed and manure, neither of which can well be spared now. Here there seems a useful opening for local distribution that could ensure distribution of manure and interchange of seedlings so as to avoid the present wasteful methods. Distribution of excess produce is another important

problem, for however well the garden is planned it is impossible to avoid an excess at one period and a deficiency at another. Unfortunately, organization of garden production is peculiarly difficult and in the past has rarely succeeded, but that is no reason why it should not again be attempted, as in the last war. Finally comes the important question of utilization of garden wastes; the best way, the keeping of pigs and poultry, is not usually possible. In any event, even if these are kept, the compost heap is an essential part of a good gardener's equipment.

THE EARTHQUAKE IN TURKEY

By E. TILLOTSON

THE greatest earthquake ever recorded in Turkey, and probably the greatest natural catastrophe which Turkey has ever suffered, occurred on December 27, when, between approximately 1.57 a.m. and 5 a.m. local time (East European), there were at least seven terrific earthquake shocks. These shocks caused havoc on and near the Black Sea coast of Anatolia in north-eastern Turkey, where, to the accompaniment of underground rumbling, upwards of fifteen towns having populations of between fifteen and forty thousand persons each, together with more than ninety villages, were practically razed to the ground, communications by telegraph, road and rail destroyed, and estimated casualties of 45,000 killed and 20,000 wounded caused.

The first news of the catastrophe was received from the Bendandi Observatory at Faenza, which reported that an earthquake of catastrophic dimensions was registered on its seismographs at 1 a.m. (Mid-European time). The earthquake was estimated to have taken place in Armenia, and the vibration at Faenza was so intense that the recording instruments were damaged. Similar news came from the Swiss observatories, and at Zurich the shock was received at 1.2 a.m. (Mid-European time). The seismograph belonging to Mr. J. J. Shaw at West Bromwich was also damaged by the earthquake, though Mr. Shaw was away from home at the time. Shortly after the news from Faenza, messages were received from Ankara stating that earthquake shocks had been experienced there.

The full force of the principal shock was felt at Erzincan, a town situated at an altitude of 4000 ft. above sea-level where a brisk trade was conducted in silks, cotton and copper. The town was immediately reduced to a heap of ruins and about 80

per cent of the population killed. The upsetting of oil lamps and stoves and the breaking of gas pipes caused hundreds of fires to break out in all parts of the town, which the surviving brigades could not extinguish on account of broken pipe lines and huge cracks in the roads. Telephone and telegraph communications were also disrupted. Here, included in the wreckage, were the military barracks and club and military school, where ten officers and ninety cadets are known to have lost their lives, though a much greater military death roll is feared. Damage only a little less severe was done at many other towns. Sivas, a town of 65,000 inhabitants, the centre of caravan routes and a collecting place for the agricultural produce grown in the surrounding districts, together with Tokat in Sivas Province, a town of 31,000 inhabitants engaged largely in calico manufacture, and the intervening villages, were practically wholly destroyed. Many people, in bed at the time of the first shock, were buried alive in the wreckage of their homes. The district of Kemah, the town of Yozgat and the town of Amasya, with a population of 30,000, in the midst of fruit-growing country, are all in ruins. At Samsun in the Trebizond district, a seaport with a population of 15,000, exporting copper, timber, tobacco, wool and other agricultural products, mosques, minarets, schools and public buildings—some of them built of reinforced concrete—and private houses came crashing down, killing thousands of people. Ordu, in the tobacco-growing district, suffered similarly, as did also Giresun, Malatya, Turhal, Gumushane, Refahive and Plumer. On the night of December 28 fires were still blazing amidst the ruined buildings, and to add to the difficulties of the rescue parties a blizzard was raging in the countryside at a temperature of 2° F. Of the 350 inhabitants of

the village of Tomruk, only three survivors have been traced. The single-storied mud houses of the peasants suffered terribly.

The first relief train on the recently opened Sivas-Erzurum railway was held up just outside Sivas because of wreckage on the line, twisted rails and huge ground fissures. Most of the geological faults already known in the area have moved, causing large crevices and permanent lateral movement. One of the principal faults along which movement has taken place has been estimated by the director of the Istanbul Observa-

though many of the great earthquakes described by Davison, and the Chilean earthquake of January 24, 1939 (*NATURE*, February 11, 1939, p. 230), probably exceeded scale 11, which indicates that few if any masonry structures remain standing, broad fissures exist in the ground, underground pipe lines completely out of service, and rails bent greatly. Scale 7 indicates that damage has been negligible in buildings of good design and construction but considerable in poorly built or badly designed structures, whilst scale 5 shocks are felt by nearly everyone, break some dishes,

SKETCH MAP SHOWING THE APPROXIMATE EPICENTRE AND ISOSEISMAL LINES (MODIFIED MERCALLI SCALE OF 1931) OF THE ERZURUM EARTHQUAKE OF DECEMBER 27, 1939.

*, EPICENTRE; —10—, ISOSEISMAL LINE.

tory to be sixteen miles deep, and many new faults have been formed.

On the basis of the macroseismic data, the accompanying sketch map showing the isoseismal lines has been constructed. The scale used is the modified Mercalli scale of 1931 originated by H. O. Wood and F. Neumann for the Carnegie Institution of Washington and the United States Coast and Geodetic Survey. This scale is numbered 1-12 in ascending order of earthquake intensity, 1 being a shock not felt except by a very few under especially favourable conditions, and 12 being a shock where the damage is total, waves being seen on ground surfaces, lines of sight and level distorted and objects thrown upward into the air. It is extremely rare for a shock to have intensity 12,

crack some plaster and overturn unstable objects. It should be noticed that such intensities are influenced by ground conditions as well as by the energy causing the displacements, and, since buildings once cracked may succumb to prolonged shaking, the total period of shaking would appear to be an important factor.

The greatest of the shocks was certainly world-shaking so far as modern seismographs are concerned, since these are capable of registering measurable ground displacements of less than 5μ (where $\mu = 0.001 \text{ mm.}$). It was registered at observatories throughout the British Isles and in the world in general. The fact that seismographs as far away from the epicentre as West Bromwich which were set for normal earthquakes were dis-

located appears to show that the surface waves *L* and *M* as distinct from the body waves *P* and *S* were of very large amplitude, indicating the release of a tremendous amount of energy from a normal or shallow focus. This also appears to be confirmed by the relatively quick decrease of destructiveness in all directions moving away from the epicentral area. The news from Istanbul Observatory also appears to indicate that the greatest focal depth of any one shock was sixteen miles.

The principal shock is estimated to have shaken the devastated area for a period of some twenty seconds, though seismograms from distant observatories occupy a much longer period of time on account of the variation in velocity of the different waves sent out by the earthquake. The epicentre of the principal shock appears to have been near latitude 40° N., longitude 38.5° E. and the initial time of the first shock about 1.57 a.m. local time (East European) or 26d. 23h. 57m. G.M.T. It must not be thought that all the seven or more shocks originated at the same time or from the same epicentre, as there is evidence to support the hypothesis that the epicentres of the shocks wandered east and west along latitude 40° N., the first being some seventy miles east of Ankara, and later southwards along approximate longitude 39° E. Also it appears to be more correct to speak of an epicentral area rather than an epicentral point. Aftershocks have continued to be numerous and severe. These, too, appear to be peripatetic along the lines above mentioned, and as yet the diminution according to the usual exponential law does not seem to have become evident. Shocks were still occurring up to December 31, and on that date a violent shock was reported at Bergama, on the *Ægean* coast.

On December 31, serious floods followed the earthquakes. These have caused further casualties and damage to houses and communications. It is now estimated that the entire population of Erzinjan, Trebizond, Tokat, Sivas, Ordu, Samsun and Amasia, totalling about two millions, are without shelter.

More than five hundred villages in the Brusa region have become marooned, and the Izmid Gulf area is totally submerged. Intermittent, though less intense, shocks occurred in eastern Anatolia on January 1. On the same day, the towns of Karacabey, Manyas and Yenisehir became inundated by the flood water, and the Rivers Nilafur, Halife and Karadere changed their courses. More villages were marooned later in the day.

It is estimated that the devastated area covers about 15,000 square miles, which is about one twentieth of the country.

A third disaster occurred on January 1, when

severe storms broke out over the Black Sea causing serious damage to shipping.

On January 2, the floods became more extensive in western Anatolia, where the Sakarya River overflowed and flooded the Bilecik valley. Light tremors were still occurring.

It has been noticed previously by Dr. C. Davison and the late Prof. H. H. Turner that violent earthquake shocks appear to be followed almost immediately by sympathetic shocks in various parts of the world and often at the antipodes. It may be that at these places where sympathetic earthquakes occur there already existed a state of tension (or compression) in the strata and 'layers' which almost amounted to unstable equilibrium, and that it only needed the trigger action of another shock in lieu of some other factor to release the energy and produce the sympathetic earthquake. The Anatolian shock was particularly violent, and therefore it was no surprise to find earthquakes occurring in other parts of the world. On December 27 about 7 a.m., San Salvador in Central America, near to which there was an earthquake on December 5, experienced earthquake shocks, as did Los Angeles in California on the same day. These are both reported to have been strong shocks, though no damage was reported. Between December 27 and 28, twenty-five earthquakes and earth tremors, two of which were of sufficient intensity to rattle crockery though none did any material damage, shook the gold-mining district of the Rand near Johannesburg in South Africa. On December 27 also, at Tangier, the north African port, deaths were reported as being due to a strong earthquake there. Previously, in 1784, Erzinjan was devastated by a severe earthquake, though the shock does not seem to have been so severe as on the present occasion.

It must be remembered that the whole of Asia Minor is a seismic zone for small shocks, as is seen by the fact that Miss Bellamy has catalogued 280 shocks as having occurred in and around Turkey between 1913 and 1930, though earthquakes in this region appear to have been stronger and more numerous of late (prior to the present shock). On September 22, 1939, two hundred people were reported killed during an earthquake which occurred in the Smyrna district (*NATURE*, September 30, p. 589). Damage and casualties occurred also in the villages of Pergame, Kotchili and Fotcha. Then so recently as November 23 last, an intense shock destroyed six villages in Anatolia (*NATURE*, December 2, p. 938), killing forty-three people besides injuring many more.

Further news of the present disaster must await the restoration of communications in the afflicted area, and the careful study of the seismograms in observatories throughout the world.