can be done by having a slit and photographic lens fixed and placing the sensitised plate upon the carriage of a dividing engine. The plate is moved along with the carriage, and when it has been exposed to the slit a desired number of times it is developed and fixed, the result being a photographic grating.

GEOGRAPHICAL NOTES.

A TELEGRAM from Zanzibar, dated January 16, states that over a hundred deserters from Mr. Astor Chanler's expedition had reached the coast and reported that he was left with only eighteen men at Daicho. It has already been mentioned (NATURE, vol. xlix. p. 112) that the expedition was deprived of Lieutenant von Höhnel's services, by an accident. We trust that Mr. Chanler may be able to reorganise his expedition, and push into the unknown country on the borders of which he has been so long detained.

THE *Times* correspondent at St. Petersburg states that Mr. F. G. Jackson, after testing his sledges and other appliances in the neighbourhood of the Yugor Strait, is returning to England *via* Lapland, and that he has not been in the Yalmal peninsula. The proposed North Polar expedition *via* Franz Josef Land, will be, if it starts, as is expected, this year, the fourth in the field. The others are the private American expedition under Mr. Peary, working from the north of Greenland; the private Norwegian expedition of Mr. Ekroll, which left the north coast of Spitzbergen in summer, relying on a new convertible sledge-boat; and Dr. Nansen's expedition, drifting northward from the neighbourhood of the New Siberian Islands.

THE death is announced, on January 20, of General Sir C. P. Beauchamp Walker, the Foreign Secretary of the Royal Geographical Society.

THE memory of Prince Henry the Navigator, to whose persistent efforts the modern revival of oceanic exploration was mainly due, is to be honoured by the celebration of the 500th anniversary of his birth, in March, with great festivities at Oporto. The proceedings will to a certain extent resemble the Columbus celebration recently held in Spain. The event they are to commemorate was even more important, since the Portuguese explorers, as a direct consequence of the encouragement of the half-English prince, discovered the ocean-road to India, and incidentally the coast of South America also, independently of the Spanish voyagers who followed in Columbus' track.

SEVERAL recent experiments on oceanic currents by means of floats have been noticed in the newspapers within the last fortnight. Mr. J. E. Muddock states in the *Times* that a corked soda-water bottle containing an addressed slip of paper which was thrown overboard by him off the entrance to the Strait of Belleisle, on July 12, 1892, was picked up on November 28, 1893, on the Norwegian coast near Kvarno, in latitude 61°.4′ N. The bottle was launched farther north than any of those placed in the water by the Prince of Monaco, but there is no clue to its course beyond that of the time elapsing before it was found, 485 days. Mr. Muddock assumes that the drift was 4000 miles, but the direct distance by sea is only 2500 miles, although it is probable that the bottle drifted south in the Labrador current before turning north-eastward with the Gulf Stream. Mr. Ballingall, of Largo, writes to the *Scotsman* that he launched a cork-covered bottle at Largo, on the Firth of Forth, on November 22, which was picked up at Akre, on the Norwegian coast (lat. 59° 19′), 460 miles distant, on December 29. Being only thirty-seven days in the water, the bottle must have drifted at the rate of not less than twelve miles a day. The bottle probably floated high and was helped by westerly winds; but in any case the rate of movement is rapid, and if the direction of the current was that usually assumed, first southward, then east, and finally north, the velocity is very remarkable.

EARTH MOVEMENTS.

EVERY year, every day, and possibly every hour, the physicist and observer of nature discovers something which attracts attention, causes wonder, and affords material for discussion At one moment we are invited to see solidified air, at another to listen to telephonic messages that are being transmitted without a wire, or to pause with astonishment before a pen which is producing a fac-simile of the writing, the sketches, and the erasures of a person who may be in a distant city. Not a day passes without a new creation or discovery, and novelties for our edification and instruction are brought to our notice at the meetings of societies and conventions which from time to time are held in various parts of the world. At the last meeting of the British Association, held in Nottingham, the attention of members was called to the reports of two committees summarising a series of facts which seem destined to open a new field in the science which treats of movements in the crust of our earth. For thirteen years one of these committees has devoted its attention to the volcanic and seismic phenomena of Japan, with the result that our knowledge of these subjects has been considerably extended. Now we observe that earthquakes, which are referred to as catastrophes in the processes of mountain formation and the elevation or depression along our coast-lines, are spoken of as "vulgar disturbances" which interfere with the observation of certain earth movements which are probably as common to England as they are to Japan.

Earthquake observations, although still capable of yielding much that is new, are for the present relegated to a subordinate position, while the study of a tide-like movement of the surface of our earth, which has been observed in Germany and Japan, earth tremors, and a variety of other movements, which we are assured are continually happening beneath our feet, are to take their place. Only in a few countries do earthquakes occur with sufficient frequency to make them worthy of serious attention. The new movements to which we are introduced are occurring at all times and in all countries, and we are asked to picture our continents as surfaces with a configuration that is always changing. We are told that every twenty-four hours the ground on which we live is gently tilted, so that the buildings in our cities, and the tall chimneys in our manufacturing towns, are slightly inclined like stalks of corn bent over by a steady breeze. The greatest tilting takes place during the night; in the morning all return to the vertical.

Why such a movement should exist, we are not told. All that we hear, is that it is too large for a terrain tide produced by lunar attraction. In Japan it appears possible that it may prove to be a concertina-like opening and shutting of the crumpled strata forming a range of mountains. To determine whether this intermittent puckering of strata, which would mean a daily increase and decrease in the height of mountains, explains the variability in the level of districts where observations have been made, is a matter for future investigation.

A problem which suggests itself in connection with this novel work will be to determine the limiting change in inclination, which we will assume means rock-bending, that culminates in sudden fracture and a jar, causing an earthquake.

Earthquake prophets up to the present appear to have lived upon the reputation of a few correct guesses, the non-occurrence of which would have been contrary to the laws of chance. As observation has shown us that a very large proportion of our earthquakes, like those which occur in the Himalayas and the Alps, and even those which occur in volcanic Japan, are produced by faulting or sudden breakages in crumpling strata, rather than by explosions at volcanic foci, it would seem that a study of the bending which leads to fracture would be a legitimate method to approach the vexed question of earthquake prediction.

Another class of movements to which our attention is called are our old acquaintances, the microseismic or tremor storms, which are now defined as long flat waves which give to the surface of our earth a movement not unlike the swell we so often see upon an ocean. Such disturbances are particularly noticeable whenever a district is crossed by a steep barometrical gradient. It is not unlikely that these movements, which are appreciable at considerable depths, have an effect upon the escape of fire-damp at our collieries, that they may influence the accuracy of delicate weighing operations—as, for example, during the determination of standard weights—that they may interfere with gravitational observations, and that they are a neglected source of error in certain classes of astronomical work. Our attention is next directed to the bending effect produced in certain districts by the rise and fall of the barometer, certain areas under variations in atmospheric pressure behaving as if they were the vacuum chambers of an aneroid.

Then there are the earthquakes of comparatively restful countries like our own. A large fault, by which mountains are suddenly lowered and valleys compressed, takes place in a distant country

like Japan. Near the origin of the dislocation the shaking brings down forests from the mountain-sides, and the neighbouring district is devastated. As the waves spread they become less and less violent until, after radiating a few hundred miles, they are no longer appreciable to our senses. But the earthquake has not ended. As long, flat, easy undulations it continues on until it has spread over the whole surface of our globe. The waves passing under Asia and Europe reach England first, while those crossing the meridian of our Antipodes and North America arrive somewhat later. At Potsdam, Wilhelmshaven, and in Japan, waves of this order have often been recorded, but for the rest of the world they are thus far unrecognised. Great cities like London and New York are often rocked gently to and fro; but these world-wide movements, which may be utilised in connection with the determination of physical constants relating to the rigidity of our planet's crust, because they are so gentle, have escaped attention.

That the earth is breathing, that the tall buildings upon its surface are continually being moved to and fro, like the masts of ships upon an ocean, are at present facts which have received but little recognition. Spasmodic movements which ruin cities attract attention for the moment, but when the dead are buried, and the survivors have rebuilt their homes, all is soon forgotten. It seems desirable that more should be done to advance our knowledge of the exact nature of all earth-movements, by establishing seismological observatories, or at least preventing those in existence from sinking to decay.

J. MILNE.

THE CLIMATIC AND NATIONAL-ECONOMIC INFLUENCE OF FORESTS.

IT is to German scientific men that we owe the first steps taken in order to ascertain data concerning the actual climatic effects of forests. Since then, however, most civilised countries, except Britain, have been actively engaged in the collection of accurate data concerning this very important subject. So far as those data have yet been collated and compared they lead to the following results.

It was not until the year 1867 that exact scientific observations were undertaken on an extensive scale to determine the actual influence which forests have in modifying the temperature of the air and of the soil within their own areas and over the surrounding tracts of country, and the first results were published in Ebermayer's celebrated work, *Die physikalischen Einwirkungen des Waldes auf Lufte und Boden*, 1873.

1. *As regards Atmospheric Temperature.*—The average results of observations made during ten years (1876–85) throughout nearly the whole of Germany, and in parts of France and Switzerland, in different kinds of forest, at heights above the sea-level varying from 10 to 3000 feet, and at latitudes varying from 47½° to 55¼°, prove conclusively that in general the annual average temperature within forests growing in closed canopy is lower than in the open, although the crowns of the trees are on the whole a little warmer in winter. The difference is greatest in summer, least in winter, and about midway between these extremes in spring and autumn; the mean annual difference, however, seldom amounts to over 1° Fahr. near the ground, and is scarcely ½° in the crowns. The prevention of insolation of the soil during the long hot days of summer, and the rapid transpiration taking place through the foliage, exert a greater influence on the atmospheric temperature than can be ascribed to shelter from wind and to decrease of nocturnal radiation.

The observations recorded prove (1) that the variations between the temperatures of the trees themselves and the air in the open exceed those between the woodland air and the latter except during winter, (2) that they are largest during the most active period of vegetation in summer, and (3) that they are greater in spring, when the circulation of sap begins, than during the autumn months, when vitality becomes sluggish and dormant.

In the crown of the trees, where insolation by day and radiation by night make their full influence felt, the difference in the daily average over the whole year is less than it is near the ground. In winter it averages little either above or below 0°, and in summer usually about the half of the reading at 5 ft. above the ground.

Observations made in Southern Germany establish the fact that in the forests it is cooler during the day and warmer during the night than in the open.

During the night the trees interfere with the radiation of heat, and in the day-time the shade afforded by the crowns keeps the air from being rapidly warmed by the sun's rays. These influences are naturally strongest during spring, summer, and autumn, when foliage is most abundant, whilst in winter the coniferous forests with evergreen foliage are milder than deciduous forests.

Owing to these differences in temperature, beneficial currents of air are induced between the forests and the open country, which follow the same law as obtains in regard to land and sea breezes. During the day the cooler and moister air of the forest sets outwards to take the place of the heated air ascending in the open; at night the current sets in from the open, cooled by radiation, towards the forest.

The statistics, upon which these deductions are based, prove that the immediate action of forests is to modify the daily maxima and minima of atmospheric temperature, whence it may be deduced that a comparison of the absolute extremes of temperature during the year must exhibit definitely the sum total of the influence exerted by forests on the temperature of the atmosphere. This modification of the extremes of temperature, which are bad alike for man and beast, and also for agricultural operations, is of immense importance from a national-economic point of view, since many places that were once fertile are now little better than barren wastes in consequence of the reckless denudation of forest.

In registering the data, however, it was observed that the geographical position, and the exposure of the forests to winds, exerted a certain amount of modifying influence in lessening the differences, and there are reasons to believe that towards the crown the forest temperature in winter is considerably higher than down nearer the ground. It was found, too, that certain forest trees exerted greater influence than others in consequence of the density of their foliage; for beech forests in summer exert, through their dense foliage and complete canopy, a considerably greater influence in diminishing the extremes of temperature than forests of spruce or Scots pine, although after defoliation their influence is merely similar to that of the pine forest, and only half so great as that of the more densely foliaged spruce.

2. *As regards Soil-Temperature.*—The influence exerted on the soil temperature by forests growing in close canopy is of considerable importance, especially with regard to the soil-moisture. The observations made concerning this point seem to make it clear that the mean annual temperature of the soil in the forest is at all the above depths of observation cooler than in the open, and that the differences are greatest in summer, about the mean in spring and autumn, and very small in winter. In countries with warm summers this reduction of the soil-temperature over large areas by means of forest growth has a decidedly beneficial result. According to observations made in Würtemberg, the difference between the maxima of soil-temperature in forests and in the open can extend so far as up to 14° Fahr.

It was also found that the daily differences in soil-temperature varied according to the season of the year, but that throughout nearly the whole year the upper layers of soil in the open were warmer in the afternoon than in the forenoon, whereas in the forest the variations were inconsiderable.

As with regard to the atmospheric temperature, the influence of the forest trees in equalising the soil-temperature throughout the year is greatest in the case of trees whose foliage is densest, spruce heading the list.

3. *As regards the Degree of Atmospheric Humidity.*—Observations recorded throughout Central Germany show that *as regards the absolute humidity of the air* forests have no appreciable climatic effect, for the annual averages showed merely slight traces of differences at 5 feet above the soil.

The differences between the relative humidity of the air in forests and in the open are, as might be expected, greatest in summer, although very different results as regard variations are obtained with changes of altitude and of other physical conditions.

The results of the various series of observations, corrected so as to eliminate, so far as possible, local differences due to altitude and other physical dissimilarities in the various meteorological stations, show that the mean annual relative humidity of woodland air is from 3½ to 10 per cent. greater than that of air in the open, but that the difference varies greatly according to the season of the year, being greatest in summer and autumn, and least in winter and spring. They show, too, that large