ment, the change in density being proportional to the change in temperature. The viscosities were determined in the Redwood I. and II. instruments, from which absolute values can be obtained by means of the relationship $\eta/\rho = AT - B/T$, where A and B are calibration constants of the viscometer. The most marked observation in the viscosity results was the relatively enormous temperature coefficient exhibited by the Mexican fuel oils. Further, the results were shown to be dependent on the previous history of the oil. For example, an oil kept at 32° F. for six days showed an increase in viscosity at 60° F. amounting to 20 per cent., while a similar specimen, heated to 93° F. for the same period, exhibited a decrease of 11 per cent. This hysteresis effect was shown to have considerable practical importance in the handling and utilisation of such oils. The viscosity of mixtures of Mexican and shale oils was described; the viscosity-concentration curves are not linear, but are sagged, and thus it happens that a relatively small addition of shale oil to Mexican oil causes a considerable decrease in the viscosity. Careful tests were also made respecting the flash points of the oils, and their mixtures. The observation was made that a bulk sample of oil flashed somewhat lower than the small amount used in the Gray instrument. These experiments were carried out by Mr. W. F. Higgins.

Dr. Glazebrook concluded by pointing out that much work remained to be done in connection with the physics and chemistry of the mixtures of complex bodies which constitute fuel oils.

QUEENSLAND RAINFALL.[1]

MR. H. A. HUNT, the Commonwealth Meteorologist, has in previous reports given concise histories of the rainfall for New South Wales and Victoria, the volume under notice being thus the third of the series to be published. This report contains all the available annual totals and number of days with rainfall recorded to the end of the year 1913 for 1040 stations in Queensland, and in addition monthly values up to the end of 1912 are given for 137 stations, so distributed as to afford a good representation over the area under consideration. Many of the records go back to 1880, and even earlier, so that a good working basis is provided for investigators who require information in regard to local seasonal rainfall, or who may wish to compare the annual variations of rainfall in this part of Australia with those of the other States of the Commonwealth. Every effort was made to obtain trustworthy data, and in addition to the official records, all possible sources of information, such as histories of Queensland and old newspaper files, were searched. Much labour was involved in the elimination of discrepancies which so often appear when the same record is published in separate reports. A very useful appendix contains tables showing the monthly and yearly values of the meteorological elements (except wind direction and velocity) at Brisbane from 1887 to 1912.

The volume is copiously illustrated by maps and diagrams, among which may be mentioned twenty-seven annual rainfall maps covering the period 1887 to 1913, a map of mean annual rainfall, monthly normal rainfall maps, an *interim* rainfall map for Papua, and a frost map of Australia. Among the diagrams are several showing the height reached by various floods at the stations belonging to the hydrometric branch of the service, and graphs giving the mean annual rainfall of the whole State of Queensland and its sub-divisions. An interesting chronological history of remarkable atmospheric occurrences fills 96 pages of the report, the data being discussed back to the middle of last century. It is worthy of note that only four displays of the Aurora Australis are on record, the cases observed occurring in the years 1869, 1870, 1894, and 1909.

For the twenty-six years, 1888 to 1913, the mean annual rainfall for the whole State is 26·50 in., that of 1894, the wettest year, 40·39 in., and of 1902, the driest year, 12·63 in. The wettest year was thus 52 per cent. above the average, while the driest year showed a defect of the same amount. In the fourteen years, 1892 to 1905, only four exceeded the average, the disastrous effect of this long-continued drought being well shown in Diagram A, giving the total number of live stock, which fell from 27 millions in 1895 to 10 millions in 1902, the decline being checked in 1903 by a rainfall in excess of the normal.

The large average rainfall map which accompanies the report shows that the maximum rainfall, indicated by the isohyet of 160 in., is centred in the vicinity of Harvey Creek (lat. 17° S., long. 146° E.), and that for about 80 miles north and south of this point a rainfall exceeding 70 in. falls on the coast and for some distance inland. An annual rainfall of 70° in. is also found on the coast in four small patches located in latitudes 15° S., 21° S., 27° S., and 28° S. The smallest rainfall under 10 in. occurs in the west and south-west of the State south of 23° S.

It would have materially helped in the elucidation of the problems pertaining to rainfall distribution had the orographical features been indicated on this map. Queensland being in the monsoon region, the heaviest rains occur in summer, while the winter is usually quite dry.

The appearance in recent years of numerous memoirs dealing with Australian climatology is a marked tribute to the rapidly-growing activity and efficiency of the Commonwealth Service, the example of which in this respect will, we hope, be followed by other weather bureaux in the southern hemisphere.

R. C. M.

[1] Meteorology of Australia. Commonwealth Bureau of Meteorology. Results of Rainfall Observations made in Queensland, including all available Annual Rainfall Totals from 1040 Stations for all Years of Record up to 1913, together with Maps and Diagrams. Pp. 285. (Melbourne, 1914.) Price 10s. 6d.

CHEMISTRY OF FIRE AND EXPLOSIVES.

IN a recent issue of the *Revue Scientifique* (September 25–October 9) Prof. A. Job has an interesting article upon the chemistry of fire and explosives. After considering the conditions for, and reactions during, ordinary combustion, the connection of explosion with combustion is described. It is pointed out that, in addition to the volume of gas evolved, heat developed, temperature attained, and pressure, another important factor remains, the rapidity of explosion. This leads to a distinction being drawn between explosives suitable for use as propellents, by reason of their progressive combustion, and what are termed in this country "high explosives," where the decomposition is initiated and propagated by shock (detonation). Mercury fulminate, nitrogen iodide, and lead azide are discussed as types of these sensitive detonating explosives. Fulminate is employed in detonators in France, lead azide being preferred in Germany, it being less sensitive to the decomposing action of moist heat.

As bursting charges for shells picric acid and trinitrotoluene are discussed, it being pointed out that whilst the former combines with metallic oxides, such as those of iron and lead, giving very sensitive compounds, and hence dangerous, the trinitrotoluene is free from this disadvantage. The higher melting point of picric acid (122°) than that of trinitrotoluene (82°) is another disadvantage, but this may be overcome by the use of certain eutectic mixtures. One such contains forty parts of picric acid with sixty parts of trinitrometacresol (*cresylite*). The mixture melts at 85°, and, after solidification, on reheating becomes plastic at 70°, which permits of compression to high density in the shell.

The various smokeless powders are dealt with, Vieille's work in the development of pure nitrocellulose powders receiving special mention. It is pointed out that, in addition to control of the rate of burning by variation in the form and size of the pieces, a greater proportion of the more slowly burning "soluble" nitrocellulose affords a means of control; thus for small arms the "soluble" may be 25 per cent., for large marine guns 50 per cent., the remainder being "insoluble" nitrocellulose.

Nobel's invention of the use of nitroglycerine as a non-volatile solvent is referred to as a great improvement, there being many disadvantages in the use of volatile solvents. A more recent non-volatile gelatiniser is dinitrotoluol, the Italian Avigliani powder being composed of "soluble" nitrocellulose fifty parts, "insoluble" N.C. twenty-five parts, dinitrotoluene twenty-five parts.

The use of stabilisers is next considered. It is shown that nitrocelluloses, like other nitric ethers, are liable to slow hydrolysis, with the formation of oxides and acids of nitrogen, these actions being promoted by moisture and rise of temperature, the rate being greatly increased by the catalytic action of the products. These actions lead to irregular ballistics, and even to spontaneous ignition. Stabilisers, of which diphenylamine is the most generally used (in ballistite, BN powder, etc.), absorb the liberated nitrogen compounds and prevent, or at least greatly retard, the decomposition.

In conclusion, particulars are given of the celebrated 75 mm. French gun. The projectile weighs 7·2 kilos., and has a muzzle velocity of 529 metres per second. The charge of powder B, in flake form, is 720 grams. It is shown that the gun, as a heat engine, gives an efficiency of 35·1 per cent. To an increase in this efficiency the author looks for further progress in the future.

THE MINUTE LIFE OF THE SEA.[1]

THE quantitative examination of the microplankton of the North European waters is the subject of the present important memoir, which is the outcome of a resolution of the International Council to take advantage of cruises in Denmark, England, Holland, Norway, and Sweden in the spring of 1912 for the collection of plankton samples taken by means of the water-bottle at depths ranging from 0 to 100 metres and more. In this way a series of accurately determined species is followed from sample to sample, and the distribution of these species is used to illustrate the laws of production and destruction of organic substance in the ocean. Prof. Gran has exhaustively examined the whole of the material collected with the exception of the greater part of the Scottish collections, for which Miss Ogilvie is responsible; a special chapter being devoted to this portion of the work. The samples were all preserved by adding Flemming's solution to the water directly it was collected. This method, although admittedly restricted, answers well for the preservation of all important Plankton species, as is shown by the fact that, when comparing the living material from Fløldeveigen, Skager Rak, with the preserved, no species were found which were not present in the preserved material. For examination, Lohmann's centrifugal method is used, and the number of organisms (cells) per litre given in a series of tables with hydrographical data. Even delicate Peridiniales such as Gymnodinium, and Infusoria, especially Labœa, are well preserved, and are shown to form an important part in the economy of the sea.

Part i. gives a descriptive account of the plankton from each area taken separately. Of these the Danish results from the Skager Rak, taken both in February and in June, are of special interest. The colder surface water of the Skager Rak in February is found to contain an exceedingly rich Diatom plankton, which the author attributes not to the low temperature, but probably to the fact that the surface water is specially rich in some nutritive substance necessary to the development of the Diatoms. In June, this rich surface Diatom plankton has almost entirely disappeared, different species of Ceratium taking their place. The Danish water investigations also bring out striking results with regard to the relations existing between the assimilating algæ and oxygen tension in the different layers.

In Part ii. new light is thrown upon the distribution and biology of the separate species. *Nitzschia delicatissima*, Cleve, is found to be the commonest of all species in the plankton from the ocean round the Shetlands and the Faroes, having in places the large density of more than a million cells per litre. With regard especially to the Ceratium species, it is shown that passive sinking of the cells plays an important part in their vertical distribution, and this statement applies also to many of the other genera. The species of Labœa are true surface forms and are very abundant: "The whole of the ocean round Scotland and the Faroes contains, at the surface, on an average, one for each cubic centimetre of sea-water."

In the extensive discussion on general conditions of life and of plankton production, taking the many factors into account, the conclusion is arrived at that with the assimilating algæ the optimum production is near the surface, although the maximum at certain periods may be at a greater depth. Thus, in the case of the Ceratium species, although in the present investigations the greater number were found to occur at depths between 15–20 metres, it does not follow that this represents the depths of optimum production. In fact, other researches show it to be generally nearer the surface. The author suggests that by far the greater number of the assimilating plankton algæ have their maxima close to the surface, probably not as deep as 10 metres.

The last portion of the work on the horizontal quantitative variations of the plankton shows the influence of the coastal waters on distribution. The entirely different conditions of the area round Scotland and the Faroes compared with the Skager Rak and the north-eastern corner of the North Sea is thus explained by their supply on the one hand from Scotland and the Faroes, and on the other through the Baltic current from the Scandinavian coastal sea. Throughout the investigation runs the same idea binding the whole together and emphasising the importance of a permanent supply of nutritive substance from land. This nutritive substance taken up by the sea forms the means of subsistence of all plankton organisms which, originating from the coastal waters, spread out from thence into the more distant waters of the ocean.

M. V. L.

[1] H. H. Gran: "The Plankton Production in the North European Water in the Spring of 1912." Conseil Permanent International pour l'explorations de la Mer. *Bulletin Planktonique* pour l'année 1912 (continuation du Bulletin Trimestriel des résultats acquis pendant les croisières périodiques et dans les périodes intermédiaires, Partie D). Publié par le Bureau du Conseil avec l'assistance de C. H. Ostenfeld, chargé du service planktonique.