industries. We can keep this increased trade only if we maintain West Indian production and, what is quite as urgent, improve West Indian grades so that they can compete with the Mediterranean. This may or may not be achieved by means of sponge culture, but it is worth trying. The Americans have undoubtedly made progress with sponge culture in Florida, and a significant fact is recorded in a recent British Colonial Report on the Turks and Caicos Islands to the effect that at one of these islands 8000 acres of sea for sponge culture has been conceded to a capitalist from New York. While we should prefer to see British enterprise of this nature, particularly in a British Possession, we have to recognise a certain consistency in United States action. Most of the marine investigation in the West Atlantic has been American; for instance, Prof. Nutting's recent and former expeditions, the study years ago on the fishes of Porto Rico by the U.S. Government, and the quite recent oceanographic work in the steamer *Bache*. It is to be hoped that Great Britain will see its way to take up the sponge question, first from the scientific, and then from the commercial, point of view, and that a start will be made at the earliest possible date.

W. R. DUNLOP.

Seaholme, Hythe, Kent, April 23.

Wasps.

THE warm spring weather which made its advent on Good Friday (April 18), and was continued on following days, brought out numbers of humble-bees, a few wasps, and butterflies of various kinds. I have usually observed that the humble-bees precede the wasps by a week or two.

A wasps' nest (*Vespa germanica*) situated in the garden here in 1915 was a rather strong one, and on digging it out in October I estimated the number of cells as 12,900. A nest of the same species which I had in 1918 was much stronger. In 1915 the hourly number of wasps flying in and out of their nest was 6500 at the most abundant period, while in 1918 the rate was no fewer than 15,500. The record heavy rains of September last, however, swamped the nest and brought it to a premature termination, when but few of the young queens had taken to flight. If the nest of 1918 had a number of cells proportionate to that of 1915, according to the hourly rate of wasps flying to and fro, then the total number of cells must have been about 30,000; but I prefer to take a more moderate estimate, and to put the aggregate at 25,000. I could not, however, actually determine the number by observation, the layers of comb being so soaked with the wet that they did not admit of detailed investigation. If each cell produces three generations of wasps, then my nest of 1918 must have been responsible for quite 75,000 wasps. Needless to relate, house-flies were not troublesome in this neighbourhood during last summer! But which pest of the two, wasps or house-flies, is the more tolerable? For my part, I greatly prefer the wasps!

Can any reader inform me as to the number of wasps supposed to be associated with a very strong nest?

W. F. DENNING.

Bristol.

THE LUNAR TIDE IN THE ATMOSPHERE.

TIDAL theory was first applied with any success to the atmosphere by Laplace, and he also first attempted to determine the tidal variation of pressure from barometric observations. His material consisted of 4752 measurements of the height of the mercury column at Brest (lat. 49° N.). These were far too few for the purpose, however, and his result, given in tome v. of the "Mécanique Céleste," cannot be regarded as a determination of the quantity sought for, which is much smaller than Laplace's value. Another lunar reduction of barometric data from Brest was made about thirty years ago by Bouquet de la Grye, but his series of observations (consisting of hourly values extending over a few years), while larger than that used by Laplace, still seems to have been inadequate. He arrived at a lunar daily inequality of pressure which was not by any means nearly semidiurnal in type, though the semidiurnal component—$0{\cdot}020 \sin (2t+100^\circ)$ mm. of mercury —was larger than the probable true value of the tidal variation at Brest.

The atmospheric tide was determined from a *tropical* series of barometric records so early as 1847. There now exist more or less trustworthy determinations for five tropical stations—St. Helena, Singapore, Samoa, Hong-Kong, and Batavia. The results for the two last are from long series of hourly observations, extending over thirty or more years, and are therefore of considerable accuracy. Though the tidal barometric variation has its maximum value at the equator, its magnitude there is very small. At Batavia (6° S.) it may be represented by the formula

$$0{\cdot}065 \sin (2t+65^\circ) \text{ mm. of mercury,}$$

where t denotes time reckoned from lunar transit at the rate of 360° per lunar day. The phase angle 65° indicates that maximum pressure occurs nearly an hour after the moon crosses the meridian.

Until recently the only determination of the tide which could be considered as probably an approximately true one, among the results for extra-tropical stations, seems to be that obtained by Morano from five years' hourly barometric observations at Rome (42° N.). Though the series of data was not large, the resulting amplitude and phase agree with what might be expected in this latitude. Many other attempts to determine the tidal barometric variation in European latitudes have been made without success. The most important of these investigations was due to Airy, who dealt with as many as 160,000 hourly observations of the barometer at Greenwich (51° N.), ranging over the twenty years 1854–73.

The barometric pressure is affected by a solar semidiurnal variation as well as, and of much greater amplitude than, the lunar tidal variation. Unless the former is properly abstracted from the hourly values before deducing from them the lunar inequality, the determination of the latter may be seriously affected by a residuum of the solar term. Two other causes operate to enhance the difficulty of detecting the lunar variation in the barometric records of stations in moderate and high latitudes. The first is the rapid diminution of the tidal amplitude as the latitude λ increases. The second is the increase in the irregular fluctuations of the pressure. At Brest or Greenwich these range over several millimetres (of the mercury column) in the course of a day, far exceeding not only the lunar, but also the solar, diurnal variation.

Even after abstracting the latter periodic oscillation from the hourly values, the elimination of the irregular changes requires the use of a large amount of observational material. Airy's discussion shows that even twenty years' data might prove insufficient. The Greenwich records of atmospheric pressure now extend over sixty years, but this threefold enlargement of the available material does not by itself ensure very much reduction in the accidental error affecting the determination. Hence, in attempting a new investigation, improvement was sought by excluding all but relatively "quiet" days from its scope, on the ground that the diminution in the number of days used is outweighed in advantage by their better quality for the purpose in hand. Rather less than one-third of the whole number of days in the sixty-four-year period 1854–1917 were retained, being those on which the range of pressure did not exceed 0·1 in. The hourly values consequently totalled about 160,000, as in Airy's work.

There are approximately twenty-five solar hours in a lunar day, so that the twenty-four-hourly values on each "quiet" solar day were supplemented by the last hourly value on the preceding day. Each such series of twenty-five observations was broken into two parts, preceding and following the lunar transit on the day in question. The preceding portion was transposed so as to succeed the other, in order that the rearranged series might correspond with intervals of, in the average, $0\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, . . . $24\frac{1}{2}$ solar hours after lunar transit. These series were written in rows, and the numbers in each hourly column were then added up, so as to enable the mean lunar diurnal inequality of pressure to be deduced. Wherever possible, simplifying devices were used in computation, and the solar diurnal variation was duly removed from the data to rid the results of this important source of error.

The accompanying figure (taken from the Q.J. Roy. Met. Soc., vol. xliv., p. 271, 1918) represents the mean lunar daily inequality of atmospheric pressure which was finally obtained. The unbroken curve, which is almost entirely semidiurnal, as tidal theory would predict, is the one deduced from the observations (the inner two vertical lines mark out a complete lunar day, on either side of which a small portion of the curve is repeated); on harmonic analysis its semidiurnal component proves to be

$$0·0090 \sin(2t + 114°) \text{ mm. of mercury,}$$

represented in the figure by the broken curve.

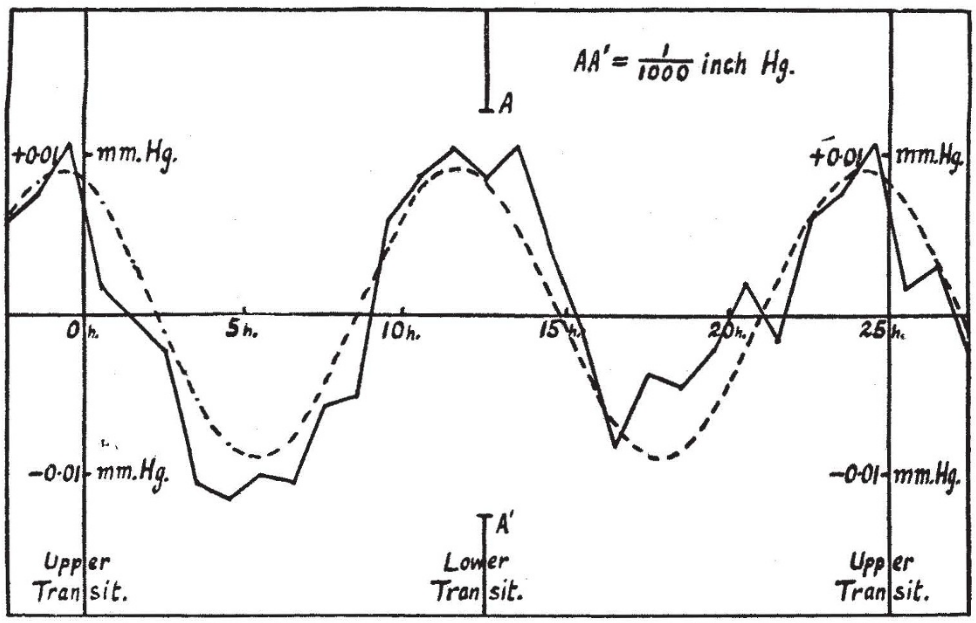

FIG. 1.—The lunar semidiurnal tide in the atmosphere at Greenwich, as determined from the Greenwich Records of Barometric Pressure, 1854–1917.

The whole range of this, in inches, is 0·00071, appreciably less than one-thousandth of an inch (indicated in the diagram by AA'). The original observations were made to 0·001 in. of mercury (from a photographic record giving a fourfold magnification); in the computations, however, the last figure in each hourly value was omitted (the previous digit being raised when necessary), the entries on the lunar sheets being made to 0·01 in. only. In the circumstances, considering the (relatively) large irregular changes of pressure, even on these "quiet" days, it is somewhat remarkable that so small a variation can be detected so clearly.

In such an investigation it is needful to guard against obtaining a fictitious result which merely happens to be of semidiurnal type. This point may be tested by subdividing the data and examining the internal agreement of the results from the separate sub-groups. In the present case the sixty-four years were divided into three periods, 1854–73, 1874–93, 1894–1917; the semidiurnal components obtained by analysis of the three corresponding mean hourly inequalities of pressure were, in mm. of mercury,

$$0{\cdot}0080 \sin (2t + 96^\circ)$$
$$0{\cdot}0089 \sin (2t + 112^\circ)$$
$$0{\cdot}0104 \sin (2t + 127^\circ),$$

between which there is sufficiently satisfactory accordance.

On comparing the determinations for Batavia and Greenwich it appears that the amplitude of the lunar atmospheric tide varies approximately as $\cos^4 \lambda$, where λ is the latitude. At Greenwich the tide is nearly an hour in advance of the moon, whereas at Batavia the order is reversed. It is possible that the amplitude and phase are subject to some modification from local causes. The fact that the observed tide is larger than the equilibrium tidal theory would predict may be attributed to the occurrence of resonance with a free period of atmospheric vibration of rather shorter duration. But, as Laplace suggested, the rise and fall of the oceans may also be partly responsible for the observed tide, and, if so, some differences might be expected between the results from oceanic and continental stations in the same latitude. The lunar tidal range of pressure is equivalent to the weight of a column of air of normal density of height 4·4 ft. at Batavia and about 7 in. at Greenwich. Hence in northern latitudes quite a small tide, existing over a considerable area, might suffice to affect the tide in the atmosphere to an appreciable degree.

S. CHAPMAN.

INTER-ALLIED CO-OPERATION IN CHEMISTRY.

INTER-ALLIED co-operation in chemistry, of which a brief notice appeared in NATURE for April 24, should be of interest to all men of science, for what is true of chemistry is very largely true of all branches of science. Men of genius have developed in all countries, and of the really important scientific discoveries the Allies have contributed at least their due proportion, if not more. But the total volume of scientific work turned out by Germany during the last fifty years has been immense, and in the application of scientific discoveries to chemical manufactures the Germans have been easily first. Moreover, in the laborious and useful work of abstracting, indexing, and publishing, the Germans have displayed their usual methodical industry; and they have not by any means under-estimated their achievements, or neglected to give them world-wide advertisement.

A good deal of antipathy to Germans and German ways now prevails, especially in those countries which have experienced German methods of devastation. French chemists and chemical manufacturers can scarcely be expected during this generation to co-operate in any way with their eastern neighbours, and they have invited the Allied chemists, pure and applied, to join them in undertaking a mass of work which hitherto has been done, and, on the whole, well done, by Germany. In chemical matters there has been during the war a considerable amount of real co-operation between the Allies. The French, Americans, and British have been of great help to each other in solving chemical problems, both of research and manufacture. It is felt that the Allies will all gain by continuing, so far as is possible, the co-operation thus begun.

Prof. Moureu presided over the recent conference in Paris, and among his French colleagues were Profs. Haller, Béhal, and Matignon, MM. Kestner, Poulenc, Marquis, and Gérard. The British delegates were Prof. Louis, Sir William Pope, Messrs. Chaston Chapman, W. F. Reid, E. Thompson, and S. Miall. America was represented by Mr. Henry Wigglesworth, Lt.-Cols. Bartow, Norris, and Zanetti, Dr. Cottrell, and Major Keyes; Italy by Senator Paterno, Drs. Pomilio, Giordani, and Parodi-Delfino; and Belgium by MM. Chavanne and Crismer.

It was unanimously decided to form an Inter-Allied Federal Council of not more than six representatives of each of the countries mentioned above, the members to hold office for three years, one-third to retire annually and be eligible for re-election. The executive body is to consist of a president, a vice-president, and a general secretary. M. Jean Gérard will provisionally act as the secretary. In addition to the council a consultative committee will be formed, consisting of as many sections as may be necessary to secure the complete representation of pure and applied chemistry. The objects of the confederation are: To strengthen the bonds of esteem and friendship existing during the war between the Allied peoples; to organise permanent co-operation between the associations of the Allied nations; to co-ordinate their scientific and technical resources; and to contribute towards the progress of chemistry in the whole of its domain.

Neutral countries may be admitted later. The next meeting of the conference will be held in London on July 15–18, that being the date of the annual meeting of the Society of Chemical Industry.

So far as Britain is concerned, the choice of representatives and the supervision of the arrangements for the first meeting will be in the hands of the Federal Council for Pure and Applied Chemistry, of which Sir William Pope is president and Prof. H. E. Armstrong the honorary secretary. Until the various nations concerned have chosen their representatives, little can be done, but Sir William Pope and Prof. Louis are provisionally acting as the British representatives, and are in communication with their French colleagues.

The meeting in Paris was held under the auspices of the French chemical societies, especially the Société de Chimie Industrielle, the president of which, M. Paul Kestner, presided at some