special branch of the subject would have had a guide to full and intelligible records of detail. Such references are nowhere given. The book is worth the extra clerical work that their insertion would have involved; but as it stands it is of little use to any one. Who, for instance, is helped by this brief paragraph on p. 64?—"Concentration of sea-water.—The process is employed in some northern salt-works, and is more economical than concentration by heat."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Movement of Sea-Gulls with a Coming Change of Weather.

IN your issue of September 7, p. 439, I read with some interest the note by Prince Kropotkin on the movements of sea-gulls upon our coasts having some connection with a coming change of weather; and that at Margate on Saturday, August 26, it was noticed such a movement was going on, the gulls passing from west of that place to the south coast, to meet, as the fishermen say, a south-west wind. It may be of interest, and as in a measure confirmatory of such a movement going on just before a marked change of weather conditions, that on Sunday evening at 5.30 o'clock six large sea-gulls passed over this place, 400 feet above the sea (situated 2½ miles due east of Cranleigh), flying in a direction south-west by south. We very seldom see gulls so far inland, but I have seen them before flying in much the same course. The direction in which these were heading would have taken them to the coast near Portsmouth, distant about thirty-five miles; and at the elevation at which they were flying, the English Channel was no doubt visible to them, for the South Downs were at the time particularly clear.

H. H. GODWIN-AUSTEN.

Nore, Hascombe, Godalming, September 12.

Thermometric Scales for Meteorological Use.

As Mr. Buchanan has called attention to the advantages of the Fahrenheit thermometric scale as compared with the Centigrade, I will state that at the Blue Hill Meteorological Observatory, while the metric system has been adopted for research work the Fahrenheit thermometer has been retained. The chief reason is the same as that given by Mr. Buchanan, namely, the occurrence of the zero in such a place as to make nearly half the readings below zero. The reading of the scale first upward and then downward is awkward, and the averaging of the results troublesome, besides making in each case a source of error. If the Centigrade thermometer is ever adopted by the English-speaking nations, I would suggest that, at least for meteorological uses, the freezing point of water be marked 273° on the scale, and the boiling point 373°. This would give meteorologists at once the temperatures which are concerned in the change of volume of gases, and embodied in a large number of the formulas used in meteorological work. At the same time it would for ever get rid of the troublesome inverted scale. In printing the results, 200 could be put at the top of the printed column, and the excess over 200 be printed at its proper place in the column. In this way most of the observed temperatures could be expressed in whole degrees by two figures as at present.

The metric system will soon be adopted, I trust, by all the English-speaking peoples. Besides the advantages of the relations of all the different portions of the system to each other, and the ease of converting smaller measures into fractions of larger measures of the same kind, every one must recognise the advantage of having one uniform system of measurement throughout the world. Almost every civilised nation except those speaking English have now adopted the metric system, and I cannot believe the English will long hold aloof.

H. HELM CLAYTON.

Blue Hill Meteorological Observatory, September 5.

THE NEW LUNAR PHOTOGRAPHIC ATLAS

MM. LŒWY and Puiseux have recently communicated to the Paris Academy of Sciences[1] continuations of their valuable descriptions of the unequalled lunar photographs they are now obtaining by means of the large Equatorial Coudé. As in the case of the three Parts of the Atlas already published, they accompany their descriptions with a discussion of the bearings of the new results obtained on the general questions of selenology. We have on previous occasions given an account of Parts i.,[2] ii.,[3] and iii.,[4] and we now give a full translation of the recent communications.

The first, which deals with the description of the photographs contained in the fourth Part, runs as follows:—

The fourth Part comprises, like the preceding ones, a positive on the scale of the original negative, and six enlargements on different scales. All these photographs, except one, deal with the waning moon, and for the first time we see the eastern edge illuminated to a certain extent. We propose to briefly indicate the most striking characteristics of the regions represented.

Plate *d* is a general photograph, in which nearly two-thirds of the visible hemisphere is illuminated, and distinguishes itself at first sight from similar positives already published. Here the work of reproduction has been directed in such a manner as to give, as far as possible, the details contained in the most brilliant parts of the lunar disc. But we also establish an intrinsic difference between the eastern and western halves of the moon, so far as the distribution of mountains and plains is concerned. Up to now we have seen the seas presenting themselves like a chain of circular basins, occupying only a zone of ordinary size on both sides of a great circle; they now take a sudden and considerable development in the direction of latitude. It appears that a large depression encountered the first, like the Atlantic Ocean across the Mediterranean deeps of our globe. These depressed parts, generally of sombre colour, are not of a uniform shade, and the darkest spots accumulate near the mountainous border. There is cause to consider these regions as more depressed than the neighbouring parts of the seas, and their distribution, as they are indicated in Plates *b* and *d*, is in accordance with what we know of the ways of the submarine depths on the terrestrial globe.

We have already noted, with regard to the third Part, the white borders which encircle Kepler and Copernicus, and which prolong themselves in different directions in long rectilinear streams. We find them here again illuminated more normally, and detaching themselves in consequence in a clearer manner. The systems of Euclid, Aristarchus, Olbers, Byrgius and Tycho, equally visible on Plate *d*, appear to us to be, like the first, depositories of volcanic cinders, carried to great heights by violent eruptions and disseminated by variable atmospheric currents. They imply with no less clearness different periods of activity, separated by intervals of repose. All the walled plains which serve as origin to a collection of such trails show under an oblique illumination a fairly equal uniform wall of some altitude. So soon as the sun has risen a little on their horizon, they shine with an intense whiteness, sometimes accentuated by the presence of a dark areola at the source of the trails. The great dimensions of Copernicus reveal other interesting facts; thus we see that the white tint is far from being equally distributed on the whole length of the walled plain, that the diameter of this surpasses by a great deal the length of the trails, and

[1] *Comptes rendus*, June 26 and July 3.
[2] NATURE, vol. lii. p. 439, 1895.
[3] *Ibid.*, vol. lvi. p. 280, 1897.
[4] *Ibid.*, vol. lix. p. 304, 1899.

that the latter are more often directed tangentially to the rampart than in a line with the centre. All these circumstances tend to make one consider the little orifices situated either on the central mass, on the ridge which limits the walled plain, or in the immediate neighbourhood, as the real seat of eruptive activity, which one might have been tempted to attribute to the orifice itself.

Plate XVIII., which comprises the southern pole, gives us a contour deformed by important excrescences. The Tycho region shows itself, at the setting as well as at the rising of the sun, rich in prominent ridges, which serve as limits to the walled plains they meet, and impose on them polygonal or elongated forms. A more attentive examination shows the existence of two superposed systems of parallel ridges, which cut the surface up into quadrilaterals. The influence of these alignments has made itself felt, not only in the primitive formation of the walled plains, but in the successive annexations which have often constituted a new wall, at some distance behind the first, as can be seen in Clavius. No trace of these angular fashions are to be found in the little parasite orifices, of recent date, which uniformly tend towards the perfect circle. Blancanus, without approaching the extent of Clavius, is classed with it by its clearness, its great depth, by the indented shadow which reproduces inequalities of the crest, and would lend itself admirably to measurements of altitude. In spite of the great differences of level noted, this region is very uniform in tint. This characteristic is due to the white colour which the Tycho trails throw over the whole.

Taken from the same cliché as the preceding one, Plate XIX. offers quite another aspect. We see plains prevailing here, sprinkled with islands and brilliant craters, furrowed with prominent veins or crevasses, and covered in certain parts by large trails which emanate from Copernicus and Tycho. We have already become familiar with this region in Plate VIII. of the Atlas. The comparison of the photographs dealing with very different phases is instructive. We note again the relative permanency of the bright areolæ, and the periodic variabiliy of the dark spots. The phenomenon of the encroachment on and of the submersion and final destruction of the walled plains can be observed here in all its degrees, and we meet with many cases where the depression has engulfed a half of the enclosure and the interior plain without affecting the rest of the rampart, or even the central crater.

Plate XX. takes us back again to the western hemisphere, to a part where the relief shows itself with extreme energy. Numerous local sinkings have here reduced the capacity of the crust, without its having to submit (to follow the contraction of the liquid centre) to a general sinking, accompanied by submersion. Various indications prove, however, that a movement of this sort has been begun. Thus, the great fracture of the Altai mountains, visible near the western edge of the photograph, skirts at a distance the sea of Nectar, and seems to prepare for its extension.

Another depressed space, also very vast, occupies the central part of the photograph, but has not succeeded in defining its contour, nor in determining the appearance of a sea. Most of the walled plains involved in this movement have amongst them a very marked family likeness, with a flat bottom and regular rampart. Those which have remained outside have kept their primitive physiognomy better, and retained in a great number of cases their central craters. Apart from these lines of circular depression, we see certain rectilinear tracts of primitive rocks extending over great stretches. As elevations they have formed an obstacle to the expansion of the walled plains. As depressions they have, on the contrary, made it easier, and many of them have transformed themselves into regular chaplets of small craters.

Plate XXI. conducts one still further west, up to the illuminated edge of the moon. The characteristics already verified in the Mare Humorum reappear in the Mare Crisium in a perhaps more accentuated degree; there are rarity of irregularities on the interior plains, elevation and regularity of the wall, persistence of a concentric terrace remaining adherent to the edge, accumulation of dark spots near the periphery. Quite near, the Mare Fecunditatis shows, besides its network of prominent ridges, large undulations of a rather convex character, like those of terrestrial seas. The intermediate plateaus, poor in walled plains, seem to be the fairly well preserved testimony of an ancient period. In the neighbourhood of Taruntius it presents a smooth region, probably levelled by an abundant volcanic deposit. Everywhere else it is furrowed with deep valleys, which tend to orient themselves along the meridian, and this direction seems to impose itself more and more on approaching the illuminated edge. A double system of alignments, cutting each other almost at right angles, prevails in the Pyrenees, which form the terminator at the upper part of the photograph, and Pétavius reveals itself, as well as many other walled plains of the first order, inscribed in a quadrilateral. Nearer the equator, Langrenus, with its double central mountain, its concentric terraces, its divergent trails, affords a quantity of eruptive characteristics which Copernicus and Tycho perhaps alone reunite in the same degree.

Collected on the next photograph (Pl. XXII.) we find, in a very limited space, five remarkable specimens of the great crevasses of the crust, that of Sabine, Sosigenes, Pliny, Ariadæus and Hyginus. The first three follow more or less the borders of a sea, and may be considered as separating a depressed region from the strip which has remained adherent to the mountainous plateau. The fissure of Ariadæus, prolonged a great stretch without regard to the relief of the surface, cutting many transversal chains, appears to date from an epoch when the crust was still disjoined and mobile in the tangential direction.

Hyginus presents, besides, quite a series of circular enlargements, which transform, as it were, a crevasse into a chaplet of craters.

The plain which surrounds Arago contains two characteristic examples of formations extremely rare at the present time. They are vast intumescences, 15 km. to 20 km. in size, in which the sinking of the central part would give rise to the ordinary physiognomy of the walled plains.

The last sheet may be recommended as illustrating well the structure of the mountainous masses of the moon, saved by some means, and left in relief after the formation of the seas.

Draughtsmen have had to content themselves here, in presence of the multitude of details, and of their variability of aspect, with a conventional figuration, where few objects, except those which form projections, could be named or identified. Our photograph renders a much more precise topographic description possible. The most peaked part of the Apennines and the Alps show a number of summits which can be recognised on the sheets of the preceding Parts, in spite of the change of incidence of the light. We see a characteristic appearing, noted by geographers as special to chains of the most recently elevated mountains, where the erosion has not had time to destroy the primitive constitution; it is a marked dissymmetry in the relief, throwing the highest summits to one side, and dividing the mass into two parts of very unequal average slopes.

So much for the descriptive matter. We now come to the second communication to the Academy, which deals with the conclusions which the authors base on the photographs.

(1) There exists, from the point of view of relief, a general similarity between the seas of the moon and the plateaus which are covered to-day by terrestrial oceans.

In these, convex surfaces are more frequent than concave basins, thrown back generally towards the limit of the depressed space. In the same way, the seas of the moon present, generally at the edges, rather pronounced depressions. In one case, as in the other, we observe normal deformations of a shrinking globe shielded from the erosive action of rain, which tends, on the contrary, in all the abundantly watered parts of the earth to make the concave surfaces predominate. The explanation of this structure, such as is admitted to-day by geologists, seems to us equally valid for the moon.

(2) In order to find an equivalent resemblance in the raised parts of the surface, one ought to be able to establish on the moon features effaced by the volcanic eruptions, on the earth those which have disappeared by erosion. We can supply this in a certain measure by comparing on the one side the lunar ranges relatively poor in walled-plains, on the other by terrestrial ranges of recent elevation, where the initial structure can be reconstituted without too much effort. We then observe, on the chains which surround the lunar seas, as on those which enclose the Mediterranean basin, the contrast of a rapid interior slope and of a slightly inclined exterior one. This contrast is often so clear on the moon, that the cause may be put down to a rupture of the strata, without waiting for any stratigraphical confirmation, which up to the present time has not been realised.

(3) The greater development in the seas of the eastern half of the lunar disc shows that the phenomena of depression must have manifested themselves at an earlier period than in the western part. If it were so, one must hold that the crust had there imprisoned gases in relatively greater quantities, and opposed a smaller resistance to their expansion. It is, in fact, on the east side that the isolated orifices show themselves in greater numbers on the surface of the seas, and that the volcanic forces have created radial systems stretching in all directions.

The development of these phenomena has necessarily required a considerable time, and there is reason to admit that these plains, solidified before those of the western part of the moon, have long ago reached a configuration little different from that which they possess to-day.

(4) The formation of the seas begins by the sinking of a vast region, which is soon isolated by a circular fracture. This fracture does not generally mark the future limit of the sea. We can mention cases where the depressed space entirely escapes submersion; others where the central part only is invaded; others, finally, where the primitive enclosure is covered, and where the sea increases by annexing marginal belts. It is by a series of analogous stages that the largest walled-plains seem to have arrived at their actual dimensions.

(5) The epoch of the solidification of a sea does not coincide with that of the positive fixing of the level in the central part. This may lower itself still more, and determine by its retreat the formation of a new crevasse, parallel like the first, to the borders of the sea.

(6) The new photographs, as well as the first, furnish us with several specimens of great walled-plains where the solidification, due to the progressive cooling, has been effected at three or even four different levels, separated by intervals of several kilometres. The modern depressions, compared with the ancient ones, are nearly always less extensive, and have a more rapid interior slope and a more regular circular form. The more modern ones, such as those which open on the bottom of Longomontanus already very depressed, present no trace of the surrounding bulge; that is to say, that their appearance does not seem to have been preceded by an upheaval.

(7) Nevertheless, this intumescence phenomenon of the lunar crust, considered by us to be the habitual preliminary of the formation of walled-plains, has in certain exceptional but well verified cases given rise to convex figures, of which the central part has not sunk.

(8) We have previously indicated how it was possible, in a fairly large number of cases, to assign the relative age of the walled plains according to the state of preservation of their ramparts, and the more or less complete submersion of their interior cavity. In the parts invaded by the trails, we can judge, by another characteristic, the epoch of the interior solidification of the walled-plain. It is convenient to place in the first line and in order of age the plains which have received and retained a uniform white covering; then those which only present some feeble and late trails, in the form of bands; lastly, those which have remained completely clear, and encroach to-day by their sombre tint on the neighbouring region.

This chronological criterion, clearer than that which depends on the state of preservation of the ridges, informs us also of the relative time of solidification in the different parts of the seas. Unfortunately, it fails us in the fairly numerous regions to which the trails have not extended.

(9) In general, the great systems of trails cover indistinctly all the undulations of the soil in their path. This circumstance has already permitted us to conclude that the formidable volcanic eruptions, of which the moon has been the theatre, belong to a recent time in the history of our satellite. They must have been preceded by the almost complete solidification of the seas, and of the bottom of the walled-plains. It seems to us the same fact must be taken into consideration in the problem, so often discussed, of the atmosphere of the moon. In fact, not only have these eruptions set at liberty great quantities of gas or vapours, but the diffusion of cinders to great distances infers a gaseous envelope of a certain density.

It is true that the relative feebleness of gravity helps one to understand their initial ascent to a considerable altitude. However, the resistance of the atmosphere must have been sufficient to retard the fall of this dust during its transport over a distance of more than 1000 kilometres.

Has the time which has elapsed since the great eruptions sufficed to bring about the total disappearance of this gaseous envelope? One is inclined to doubt it, on examining the mechanism of the two principal causes which could have operated in this direction. The crust, already everywhere solidified, could only have absorbed the gases slowly and with difficulty. The loss in space of molecules with a velocity great enough to carry them into the sphere of attraction of another body became of necessity less and less in proportion as the temperature became lower. We find, therefore, in the examination of the lunar surface serious ground to believe that there exists, at the present time, a residue of atmosphere of which the detection, surrounded as it is with great difficulties, may yet be realised.

This induction adds itself to that which has been furnished, as we have seen by the discussion of eclipses and occultations. The care which astronomers have for some years given to the study of these phenomena, and the great number of occultations of small stars which may now be observed at each total eclipse, give reason to hope that this discussion may soon be resumed on a new basis, and lead to more precise conclusions.