different temperatures cannot be precisely stated, the *Challenger* results leave no doubt that more carbonic acid is absorbed the lower the temperature is. Taking the mean of all the *Challenger* determinations in surface water at temperatures between 10° C. and 15° C., we have 43·5 mgr. per litre of carbonic acid liberated by boiling to nearly dryness after precipitation of the sulphates; and this agrees to a fraction of a milligram with Tornoe's average amount of carbonic acid present as bicarbonate.

Dr. Tornoe concludes this part of the work with an interesting inquiry into the condition in which the carbonic acid exists in the water, and comes to the conclusion that it is probably present in combination with soda, forming bicarbonate of soda.

In the third portion of his work Dr. Tornoe gives an account of his experiments on the amount of salt held in solution by the sea water. For determining it he follows two methods, the one depending on the specific gravity, and the other on the chlorine contained in the water. The specific gravity was determined by means of suitable glass hydrometers, and the chlorine by means of silver solution of known strength. In order to reduce the specific gravities which were observed at various temperatures to their value at one standard temperature, Dr. Tornoe reports an elaborate series of experiments on the expansion of sea water due to change of temperature, and he uses the result too obtained along with those of Ekman for reduci[illegible] results. They are given in two columns; in [illegible] is the specific gravity at 17·5° C. referred to [illegible] of distilled water at the same temperature as unity; [illegible]n the other they are reduced to their value at the temperature of the water when *in situ*, referred to distilled water at 4° C. as unity.

In order from these results to arrive at a knowledge of the amount of solid matter dissolved, he makes a series of careful determinations of solid residue of chlorine and of specific gravity in seven samples of water. He finds that "the co-efficient of chlorine may be taken at—

$$1·809 \pm 0·00076$$

with a probable error in a single determination of ± 0·002, and the co-efficient of specific gravity at—

$$131·9 \pm 0·058$$

with a probable error in a single determination of ±0·15." The specific gravity is here taken at 17·5° C., and the unit is that of distilled water at the same temperature.

The determination of the solid residue in sea-water presents special difficulties due to the presence of so large amounts of magnesia salt. These difficulties are overcome in an ingenious way:—"From 30 gr. to 40 gr. of sea-water were introduced into a thick porcelain crucible of known weight furnished with a tight-fitting cover, and evaporated on a water-bath. So soon as the salt was sufficiently dry the crucible with the cover on was heated for about five minutes over one of Bunsen's gas-burners, then cooled and weighed with its contents."

The free magnesia liberated by this process was then determined by dissolving the salt and adding a quantity of titrated sulphuric acid and determining what remained unneutralised by titrating with caustic soda.

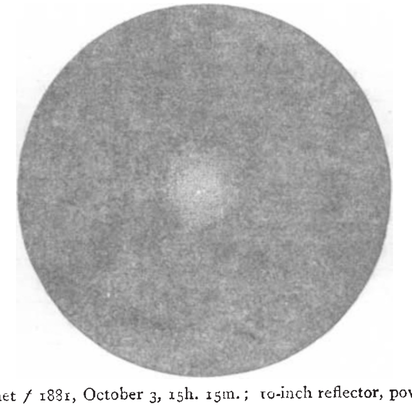
The results so obtained are given in a table, and also represented graphically in charts at the end of the work. These charts show very clearly the distribution of the water from the Atlantic amongst that coming from Polar regions, which is also confirmed not only by the temperatures observed, but also by the distribution of nitrogen dissolved in the bottom water, of which Dr. Tornoe has given a chart. It is well known that the water coming up from the North Atlantic is much salter than that coming south from the Arctic and Polar regions. From the variations in the amount of salt found in the bottom water of different districts Dr. Tornoe suspected that some of it must be due to the presence of Atlantic water which had got cooled on its way north, and had sunk to the bottom. It is in the highest degree probable that the nitrogen found dissolved in a sea-water, taken from any depth, is the nitrogen which it took up when last exposed to the atmosphere. Now the amount of nitrogen which it would take up would depend to a great extent on the temperature, so that water which had been exposed at the surface in Arctic regions would take up more nitrogen than water which had been exposed in temperate regions, so that the amount of nitrogen present, for instance, in a bottom water, may be taken to indicate the temperature which the water had when last exposed to the atmosphere. Now it is a remarkable result of Dr. Tornoe's investigations that where he finds a high percentage of salt in the bottom water he also finds a low percentage of nitrogen, and *vice versâ*, rendering it in every way probable that the areas which he has mapped out are really supplied on the one hand from the Atlantic, and on the other from the Arctic Oceans. This result is a further evidence of the importance of accurate determinations of the gaseous contents of sea-water.

It is impossible to conclude this notice without congratulating the Norwegian nation on the advanced position which it has taken up in ocean exploration and the success which has attended the labours of its servants, and in an especial way of Prof. Mohn and those associated with him in the three summer trips of 1876, 1877, and 1878. Not only is the work done great in amount and of the highest scientific interest, but it has been published with a praiseworthy expedition which adds immensely to its present value.

J. Y. BUCHANAN

COMET *f* 1881

ON the morning of October 4, 1881, while engaged in sweeping the eastern sky for new comets, I found an object about 10 degrees preceding α Leonis on the ecliptic which bore a strong resemblance to a bright round nebula, with a marked condensation in the centre. I roughly estimated the position of the object, and referring to Herschel's catalogue of nebulæ, endeavoured to identify it, but without success. Then carefully noting its place relatively to the small stars in the same field of my



Comet *f* 1881, October 3, 15h. 15m.; 10-inch reflector, power 25.

10-inch reflector, I resumed sweeping in the region near. About half an hour later—3 45 a.m.—I re-observed the object, as clouds were rapidly coming up. A slight motion to the eastward was at once suspected to have occurred in the interval, but my positions were merely eye estimations, and I distrusted them though feeling certain at the time that the supposed displacement was real. I had only obtained a momentary glimpse when the sky became completely overcast, but fortunately the ensuing night was cloudless, and I was enabled to obtain another observation. The suspected object did not rise until soon after 1 a.m., and I knew that it would not come under the range of my 10-inch reflector before about 2h. 30m. a.m. Apart from this, the moonlight was very troublesome. Adjusting the telescope I immediately saw the small stars of the preceding night, but the nebulous object had disappeared though it was found directly afterwards in a place about half a degree east of its position on the previous morning. The true character of the object thus became unmistakeable. It was a telescopic comet with an apparent motion towards the sun, though really the distance between the two bodies was daily becoming greater, owing to the fact that the sun's apparent motion eastwards along the ecliptic was about twice as great as that of the comet.

Information of the discovery was telegraphed to Greenwich and Dun Echt, and subsequently the Astronomer-Royal sent notification to some of the chief foreign observatories. Coggia at Marseilles, the discoverer of the great comet of 1874, picked up the new comet on the night (October 5) following the receipt of the telegram, and on October 9 it was observed by Messrs. Lohse and Copeland at Dun Echt. But at Harvard College Observatory (U.S.) it was looked for in vain, for the comet managed to elude detection until a special message had been dispatched from Lord Crawford's observatory, giving its accurate place, when it was ultimately found by Mr. Wendell. It was observed at the latter station on the nights of October 10 and 11, and the positions obtained then, in combination with a Dun Echt place of October 9, enabled Mr. Chandler to compute approximate elements, from which it appeared that the comet was receding both from the earth and the sun, and the orbit presented some resemblance to that of the comets of 1819 IV. and 1771 I. Parabolic elements were subsequently computed by Messrs. Copeland and Lohse, by Dr. Oppenheim at Vienna, J. Palisa at Wien, and by Mr. J. R. Hind at London. It soon became evident however that an elliptical orbit would best satisfy the later observations, and M. L. Schulhof at Paris was the first to compute them, using the Marseilles position of October 5, Dun Echt October 9, and Paris October 18. He gave the period as $7\frac{3}{4}$ years, though admitted that a considerable amount of uncertainty was attached to this result. Elliptic elements were also computed by Prof. Winnecke at Strassburg, by Mr. S. C. Chandler at Boston (U.S.), and by Herr Block at Odessa, the resulting periods being 8·407 years, 8·343 years, and 9·106 years respectively. Schulhof also reconstructed the orbit on the basis of many later positions, and deduced the period as 8·45 years, which is in very close agreement with the results of Prof. Winnecke and Mr. Chandler. The following are the elements as computed by Messrs. Schulhof and Winnecke respectively :—

Perihelion Passage, Sept. 13·25866 Berlin mean time.

	° ′ ″
Longitude of perihelion	= 312 21 0·4
Longitude of node	= 65 57 50·0
Inclination	= 6 51 36·2
ϕ	= 55 37 25·8
log. q	= 9·860192
log. e	= 9·916637
log. a	= 0·618020
Period	= 8·45 years.

Perihelion Passage, Sept. 13·1697 Berlin mean time.

	° ′ ″
Longitude of perihelion	= 312 11 22
Longitude of node	= 66 4 2
Inclination	= 6 52 36
ϕ	= 55 34 7
log. q	= 9·859955
log. a	= 0·616427
Period	= 8·4072 years.

Herr Block finds the period 9·106 years, and remarks (*Science Observer* Circular, No. 21) that "the orbit of the comet is similar to the orbits of comets 1743 I. and 1819 IV., which Prof. Clausen supposed to be identical (*Ast. Nach.* x. p. 363), but, in this case, the time of revolution should be nearly 7·7 years. The orbit is also similar to the orbit of the comet of 1585, excepting that the perihelion distance is very different. Supposing that there were 17 revolutions between 1585 and 1743, and 15 revolutions between 1743 and 1881, the time of revolution would be 9·252 and 9·253 years. The comet of 539 also accords with the period of 9·25 years."

M. Schulhof says that the period may possibly be larger than that assigned in his elements, as there are deviations in the middle places of the orbit seeming to suggest such a conclusion. It is explained in *Science Observer*, No. 35, p. 94, that this comet approaches nearer to the earth than any other, except that of Biela, of whose continued existence we are becoming very sceptical. It is singular that the new comet evaded discovery so long, for it must have been a conspicuous object in the southern hemisphere in August, for on the 18th of that month it was "within 11,000,000 miles of the earth, and its brilliancy equal to forty or fifty times that at discovery, and in fact easily visible to the naked eye."

The last observation of this new periodical comet was made, I believe, by Prof. Winnecke on November 19 with the 20-inch refractor at Strassburg Observatory, when the position was a = 10h. 40m. 32·92s., $\delta = 14° 49' 30''\cdot7$ N. at 16h. 46m. 38s. Strassburg mean time.

As this comet approaches somewhat near to the earth, the idea occurred to me that it might very possibly be associated with one of the numerous meteor streams which I had observed during the few preceding years, but the theoretical radiant point of the comet is a southerly one, and is so near the sun that the chances of its observation are very meagre. Prof. Herschel computes that the earth passes the comet's ascending node on November 28, when the radiant point of any meteors following the orbit of the comet would be at R.A. 272°, Dec. 37° S., which is near ϵ Sagittarii, and 29° south—following the sun's place. The meteor speed would be = 14 miles per second, but the shower could only be observed in the early evening, inasmuch as the radiant sets about half an hour after the sun. On December 14 the cometary orbit passes + ·033 N. of the earth's orbit, and the radiant point is at a 277°, δ 34° S., but in this case also a shower of meteors proceeding from the comet would be invisible, because the radiant sets with the sun.

A good deal has been said with reference to the supposed resemblance of orbit between this comet and Blanpain's (1819 IV.), but if they are identical the orbit and period have undergone remarkable changes since 1819, and the question cannot be definitely settled until the perturbations arising from the action of Jupiter have been investigated. It must be admitted that some comets, as for example Lexell's, have been drawn into new orbits by planetary influence, and it is possible that the cumulative effects of this may have brought about a lengthening of the period in the present case, for the period of Blanpain's comet, as computed by Encke, was only 4·81 years, which is not considerably more than one-half that of the new periodical comet. Whether the latter will return at its predicted epoch in 1890 is open to some conjecture, but a careful investigation of the orbit and of the perturbations which must affect it in the interval, will to a great extent remove the difficulties. The comet is evidently a bright one, and in certain positions will be presented as a conspicuous object, so that it may have been frequently observed during former returns to perihelion, though the great variations in its orbit originated by perturbation, make it difficult to reconcile the orbital elements at different returns. The comet may also have often escaped discovery at its re-appearances similarly to the perodical comets of Encke and others, which must manifestly increase the difficulty of fixing with any degree of certainty the epochs of its former apparitions. It is, however, satisfactory that the comet at its recent return was fairly well observed, and its elliptical elements having been computed on several hands with marked consistency, we may assume that its present form of orbit is known with considerable accuracy. W. F. DENNING

THE MAKING OF ENGLAND[1]

IN an instructive article in *Macmillan's Magazine* for this month, Prof. Geikie shows what important influences the geological development of our country has had upon its history. Prof. Geikie begins in long past prehistoric times, when England formed part of the European continent, and rapidly traces the changes which have gone to make England what it is; shows the bearing which the physical geography of the country had on the settlements of the early inhabitants, pre-Aryan and Aryan, and in later times on the development of England's commerce, and the growth of her greatness. What Prof. Geikie does for England as a whole Mr. Green attempts to do for "Anglo-Saxon" England, for that England which was destined to form the broad basis of the England of the present day. Mr. Green, in his well-known "History of England," as we pointed out at the time of its publication, made some attempt to take account of the physical conditions of our country in so far as they have influenced her history; and this is essentially the method he followed in his valuable text-book of British Geography. Hitherto historians have taken little or no account of the environment of nations, although it is evident that that must be a factor of the first importance in determining the character of a people and their historical development. In a general way every one must admit that the climate and physical condition of a country have their influence on the character of a people; but in its strictly scientific aspect the subject is yet in its infancy, and we hope that Mr. Green's example will encourage others, both historians and scientific geographers, to work it out thoughtfully and minutely. It is not our province to examine Mr. Green's work critically, as an historical treatise; we shall leave it to others to say whether all his statements and inferences are authorised by the documents on which they are based. But that the work is full both of interest and instruction every one must admit. Mr. Green's geographical and topographical instincts are unusually keen, and his faculty for clothing the dry bones of chronicles, and antiquarian discoveries, and ethnological data with living flesh and blood is probably unsurpassed. In a series of pictures he brings before us our Teutonic forefathers with a vivid force that has all the interest and excitement of reality. We see them hovering off the shores of England, even while the Romans were in possession, watching their opportunity to pounce down upon the prosperous towns and homesteads; we see them at last get a firm footing, south and east and north, holding the coast regions with comparative ease, but baffled for years by the primeval forests and thick underwood, the widespread marshes and impassable rivers. Not for at least two centuries were they able quite to overcome these obstacles, and these, with the other physical features of the country, determine the relative positions ultimately occupied by Jute, Angle, Saxon, and Celt. With regard to the last-mentioned, Mr. Green, from a study of the finds in the Settle and other caves, is able to bring before us a touching picture of the flight of the Celtic men, women, and children with what utensils and ornaments they could carry with them before the advance of the ruthless Saxon.

"The hurry of their flight may be gathered from the relics their cave-life has left behind it. There was clearly little time to do more than to drive off the cattle, the swine, the goats, whose bones lie scattered round the hearth fire at the mouth of the cave, where they served the wretched fugitives for food. The women must have buckled hastily their brooches of bronze or parti-coloured enamel, the peculiar workmanship of Celtic Britain, and snatched up a few household implements as they hurried away. The men, no doubt, girded on as hastily the swords whose dainty sword-hilts of ivory and bronze still remain to tell the tale of their doom, and hiding in their breast what money the house contained, from coins of Trajan to the wretched 'minims' that told of the Empire's decay, mounted their horses to protect their flight. At nightfall all were crouching beneath the dripping roof of the cave or round the fire that was blazing at its mouth, and a long suffering began in which the fugitives lost year by year the memory of the civilisation from which they came. A few charred bones show how hunger drove them to slay their horses for food; reddened pebbles mark the hour when the new vessels they wrought were too weak to stand the fire, and their meal was cooked by dropping heated stones into the pot. A time seems to have come when their very spindles were exhausted, and the women who wove in that dark retreat made spindle whorls as they could from the bones that lay about them."

Then, when the invader has settled down in his conquests, the author restores to us with the broadness of reality, partly with material obtained by the researches of the archæologist, their mode of life, the nature and disposition of their *tuns* or settlements, the life of earl, ceorl, labourer, and slave, and to show us in the town *moot* the germs of our modern complicated parliament.

Mr. Green has evidently taken the greatest pains to master the physical geography and the great topographical features of the country at the landing of the Teutonic invaders. It was in many respects as different as possible from the surface with which we are at present familiar. The New Forest, Cranbourne Chase, and other scanty forests are but the remains of what at that period was almost one universal forest, impenetrable to all but natives, thickly clothed with underwood, and from which the great chalk-ranges rose, and provided almost the only settling-places of the inhabitants. Nowadays we find all our great cities along the river valleys or the coast; then the uplands were the only areas on which the inhabitants could settle, the marshy and wood-grown banks of the rivers being all but uninhabitable.

"It was not merely its distance from the seat of rule or the later date of its conquest that hindered the province from passing completely into the general body of the Empire. Its physical and its social circumstances offered yet greater obstacles to any effectual civilisation. Marvellous as was the rapid transformation of Britain in the hands of its conquerors, and greatly as its outer aspect came to differ from that of the island in which Claudius landed, it was far from being in this respect the land of later days. In spite of its roads, its towns, and its mining-works, it remained, even at the close of the Roman rule, an 'isle of blowing woodland,' a wild and half-reclaimed country, the bulk of whose surface was occupied by forest and waste. The rich and lower soil of the river valleys, indeed, which is now the favourite home of agriculture, had in the earliest times been densely covered with primæval scrub; and the only open spaces were those whose nature fitted them less for the growth of trees, the chalk downs and oolitic uplands that stretched in long lines across the face of Britain from the Channel to the Northern sea. In the earliest traces of our history these districts became the seats of a population and a tillage which have long fled from them as the gradual clearing away of the woodland drew men to the richer soil. Such a transfer of population seems faintly to have begun even before the coming of the Romans; and the roads which they drove through the heart of the country, the waste caused by their mines, the ever-widening circle of cultivation round their towns, must have quickened this social

[1] "The Making of England." By John Richard Green, M.A., LL.D Maps. (London: Macmillan and Co., 1881.)