as with the white ant and mud-wasp are the results of intelligent observation and experience.

But it has become automatic! Brain and manipulating organs fulfil their allotted task without experience and instruction!

Here the parallelism with man is certainly no longer perfect; there is a divergence, but a divergence due only to the same laws acting on two sets of modified conditions. Man has developed by radiation in ever-widening circles and is still in course of an all-round development. The insect has developed along a narrow line and has reached the limit of his capacity, but that limit surpasses man's utmost attainments, both in clearness of perception without intellectual effort, and in facility of execution. The knowledge and capacity of execution gained by observation and experience have become constitutional. Man, in spite of the great breadth of his intellectual range, does occasionally reach something like the inherited clearness of perception and facility of execution of the insect, at special points of the circle; as, for example, in the inherited musical powers of a Mozart and other born composers, who have been capable of composing as automatically as the bee makes its cell; and I assume for both a similar intellectual gratification in the exercise of their powers. Look again at the born arithmeticians and mathematicians; or, again, at the achievements of a Siemens. Does any one suppose that these involve the intellectual labor performed by the average tyro struggling to overcome some petty difficulty? Great results have unquestionably been achieved by enforced attention and patient labor, but the greatest achievements arise by unconscious reflex action of the brain to the stimulus of inherited memories which evolves the idea before it even rises into consciousness. It is precisely this clearness of perception and facility of execution, recognized as genius in man, which characterize the special labors of insects and other of the lower animals in their special narrow fields. Further, all naturalists who have given close study to the hymenoptera, for instance, will, I think, support me in the conclusion that the automatic facility displayed in their special tasks is accompanied with intellectual resources which enable them to deal intelligently with emergencies which may arise in the course of their performance.

We may find a still closer parallelism between man and the lower animals in the matter both of inherited perceptions and capacities of performance on a lower intellectual plane, which being part of every man's experience, the relation of inherited to acquired ability will be the more readily appreciated. Every child knows intuitively that an apple is good to eat. On this point his perceptions are clear, his convictions not to be shaken. This is a familiar instance of inherited perception or brain memory. In fighting we have an illustration of muscle-memory. A fistic encounter calls forth as diversified and complicated a series of activities as almost any species of manual labor, but a ten-year-old boy of fighting stock will stand up to his first fight and play his part with a skill and address and promptitude such as he could not acquire in any industrial pursuit without considerable training.

These are only particular illustrations of a well-known general law. Any muscular or mental labor long persisted in is attended with a facility of execution which in time becomes constitutional in the race. Man is immeasurably removed from the lower animals by his wider range of perceptions and capacities, but we cannot form a better idea of the intellectual status of the lower animals, within their narrow limits, than by speculating on a future ideal stage of human evolution, when every child born into the world will, as his intellect unfolds, display, without instruction, the mathematical genius of a Euclid, the musical powers of a Mozart, the logical powers of a Bacon, and the comprehension of character of a Shakespeare.

THE DATE OF THE LAST GLACIAL EPOCH.

BY MAJOR-GENERAL I. C. COWELL, WINDSOR, ENGLAND.

Now that the untiring labors and vast research of such men as Professors Wright, Prestwich, and Emerson, Dr. Andrews, and Messrs. Gilbert and D. Mackintosh have resulted in such remarkable coincidences as to the period of the termination of the last glacial epoch, England, as America, may well be congratulated upon such achievements by their men of science in that intensely interesting field of enquiry; but our satisfaction would be far from complete if we did not find confirmation of these results in those of astronomical discovery, which give evidence of that perfect harmony which has so long been sought for in vain by astronomers and geologists and by all those who have awaited the revelation which unquestioned facts have at last disclosed. These are to be found in the beautiful discovery of Major-General Drayson of the Royal Artillery (formerly professor of astronomy at the Royal Military Academy at Woolwich) of the second rotation of the earth, whose works, entitled "30,000 Years of the Earth's Past History" and "Untrodden Ground in Astronomy and Geology" (published by Chapman & Hall and by Paul, Trübner & Co. of London), afford the most striking testimony to the accuracy of the calculations of the gentlemen referred to.

In so short a notice as this it is only possible to give a general outline of the discovery, which has occupied nearly thirty years for its full development, resulting in the discovery that the glacial period, or, more properly speaking, periods, occupy about 20,000 years, whilst the last terminated about 6,000 years ago. This, however, is but one of the results of the discovery.

The earth has three principal movements, the first being its daily rotation, the second the annual revolution of the earth round the sun, and the third a slow second rotation of the earth which causes the half axes of daily rotation to trace cones during a period of about 31,600 years.

The second rotation, more accurately defined, consists in the pole of the heavens describing a circle round a point, which is ascertained to be situated six degrees distant from the pole of the ecliptic, having a right ascension of 270 degrees, and at an angular distance from the pole of the heavens of 29° 25′ 47″, this angle depending upon the position of the centre of gravity of the earth, the earth being considered as a gyrating sphere, and so following the ordinary laws of gyration.

The two semi-axes of the earth by this movement describe cones, having their apices at the centre of gravity, which in the case of the earth nearly corresponds to the centre of the sphere. From the knowledge of this law, and from these data, the polar distance of a star can be at once calculated for more than a hundred years from one observation only, and to the decimal of a second of an arc, a result which hitherto could only be attained by constant observation and laborious calculations by the method adopted by astronomers in ignorance of the properties of this rotation.

The obliquity of the ecliptic can be ascertained for any time during the revolution of the poles, which are calculated to occupy 31,682 years in completing the circle. Hitherto the time supposed for the completion of this conical motion was about 25,000 years, during which period scarcely any variation occurred — so it was asserted — in the extent of the Arctic circles and tropics.

By a knowledge of the second rotation it is proved that a variation of twelve degrees in the extent of the Arctic Circle and tropics occurred not later than 13,500 B.C. The procession of the equinoxes is ascertained to be the result of this second rotation, and due to no other cause; and the rate of procession can be ascertained at any time, this, it may be mentioned, being proportionate to the sine of the obliquity of the ecliptic at the time indicated, in its every-varying amount from the minimum of 23° 25′ 47″ to the maximum of 35° 25′ 47″.

With such a difference, it follows that at the height of the glacial period — that is, when the obliquity attains to 35° 25′ 47″ — the Arctic Circle will have crept down towards the equator in both hemispheres twelve degrees, which will thus cause the tropics to extend to the same amount towards the poles, and so extend the tropical zone from Cape Hatteras to the River Plate.

Under such conditions the human mind fails to conceive the vast changes which must be brought about during every six months from the mighty floods caused by the intense summer heat and the intense cold of the Arctic winter, alternating with each other.

It is to such changes of temperature that we find the remains of Arctic and tropical animals imbedded together in the same

drift in their migrations towards those latitudes which their natures demanded, and so must man move in accordance with the necessities of the time as regards temperature and its consequences.

It is calculated that we are about 403 years distant from the time when the pole of the heavens in its revolution, the pole of the ecliptic, and that of the second rotation will be in the same colure — that is, in the year 2295 A.D.; and then the least differences in temperature between summer and winter will be experienced. From that time forward this difference will increase, and about 6,000 years later — or about the year 8300 A.D. — the earth will enter upon the next glacial period, and attain its greatest severity about the year 18,136 of our era; that is, when one half-revolution of the pole, occupying 15,841 years, will have been completed from the point indicated, of the pole and two centres being in the same colure.

The evidences of geology now attest the accuracy of this discovery, though twenty years later than it was discovered by this astronomer. Herschel, in his "Outlines of Astronomy," described the movement of the pole as describing a circle round the pole of the ecliptic as a centre and at a uniform distance from it of 23° 28′, though in another article he admitted a decrease of obliquity of 48″ per century; and these two contradictory assertions appear to have been copied or misunderstood by astronomers and mathematicians for more than a hundred years. Twenty-five years ago General Drayson pointed out the error, but no attention was paid to this. Now, however, all who look for the truth will receive a fresh impetus to independent enquiry, and signs of a change are already appearing which nothing can arrest, substantiated as his calculations are by the observations of the last 2,000 years.

In concluding these remarks, it may be observed that the axis of the planet Uranus very nearly coincides with the plane of its orbit, which varies only about 46′ from that of the earth, and astronomers, observing that its satellites moved in a contrary direction to that of the other planets, assumed that the satellites of Uranus "moved in opposition;" but General Drayson pointed out that this was not the case, and explained that it depended upon which pole of the planet was turned toward the earth which way the satellites would appear to revolve, whilst their real motion round the planet was not in opposition, but in conformity with the law that all satellites move round their primaries in the same direction.

It is possible that this discovery has never been suitably acknowledged by any scientific society, but in a work published in 1862, viz., "Common Sights in the Heavens," General Drayson, at pages 172 to 175, pointed out that former writers on astronomy had been in error in attributing to the satellites of Uranus a movement different from that of any others in the system. His geometrical proof of this fact is very simple, and it seems surprising, when we see the solution of the mystery, that writer after writer on astronomy should have copied each others' mistakes for more than seventy years.

Lastly, it is to be hoped that the discoverer of the second rotation may live to see the triumph which he has achieved universally admitted by all true lovers of science.

ALABAMA BAUXITE.[1]

BY HENRY MCCALLEY, UNIVERSITY, ALA.

BAUXITE was first discovered in Alabama in 1889. The first discovery was at the Dykes Limonite Banks, Cherokee County. Since then it has been found at the Walker Limonite Banks, near Jacksonville, Calhoun County, and at the Laney Old Manganese Banks, Cleburn County.[2] These deposits are all in the lower part of the Lower Silurian. The Cherokee and Calhoun deposits are at the bottom of the Knox Dolomite of Safford of Tennessee, now believed to be Upper Cambrian. The Cleburn deposit is in the upper part of the Weizner Quartzites, Middle Cambrian, believed to be identical with the Chilowee Sandstone of Safford. They are all in sections of country that are badly broken up by sharp folds and great thrust faults, and in which the characters of the rocks have been greatly changed, doubtless by the great heat produced in their folding and faulting. They are all pocket deposits, though they occur along regular leads and show more or less stratification in all of the cuts that have been made upon them. They occur about as do the limonite and clays with which they are closely associated, though they appear to show more evidences of stratification. They are so closely associated with the limonite and clays that their deposits appear to be greatest where the limonite and clay deposits are greatest.

The Cherokee deposits appear to occur along the crest of two sharp parallel anticlinals covered by *débris*, that run in a general north-east and south-west course and are from 150 to 200 yards apart. Between these anticlinals is a sharp synclinal, and it is more than probable that some of the bauxite deposits of the opposite anticlinals, as irregular stratified seams, are connected or are continuous, under the surface, across the synclinal trough. The largest limonite and clay deposits of this immediate section are in the synclinal trough, and it is believed that future developments will show the largest bauxite deposits to be also in the trough. The bauxite, in places at least, is on the top of a friable sandstone and under or in the lower part of an unctuous clay. The limonite is usually on the top or in the lower part of this unctuous clay. In places, however, there is bauxite seemingly on the top of the limonite, and in still other places it occurs in the clay as large masses and as small nodular concretions.

The Calhoun deposits, in the few shallow cuts that have been made upon them, also appear to be on the top of a sharp anticlinal. The Cleburn deposit has never been dug into and shows only as a few loose bowlders on the surface.

The Alabama bauxites have not as yet been dug into sufficiently to enable even a rough approximate estimate to be formed as to their quantity, still enough has been done on the Cherokee deposits to show that they alone have in them an immense amount of ore. They show on the dip in limonite old diggings to the depth of 75 feet. In one limonite old digging, the Dykes Bank proper, the bauxite, as an irregular seam about 60 feet thick, shows from the top to the bottom of the digging about 75 feet deep. This is the only place in which the full thickness is shown, though in half a dozen other places from a few feet to 50 feet in thickness of it can be seen. It has been seen by the writer at intervals on both of the anticlinals for a distance of about one and a half miles, and it is said to show at intervals on both anticlinals for a distance of nearly five miles.

The Calhoun deposits show at intervals in a north-north-east and south south-west course for about 250 yards. They have not been dug into sufficiently to show either the thickness or even the quality of their ore. In one of the pits or trenches, however, a thickness of about 25 feet of ore can be seen.

The Alabama bauxites are mostly concretionary or pisolitic, though some of them are earthy or clay-like. The eyes or concretions are usually of the size of a small pea, though sometimes they get to be irregular concretionary nodules of some two inches in diameter. The earthy or clay-like variety has often a metallic ring. The Alabama bauxites are of white, red, and gray colors.

The Cherokee bauxite, in car-load samples as sent to the manufacturers, is said by Mr. J. M. Garvin, superintendent of the Bass Furnace Company, Rock Run, Ala., to have about the following approximate analysis:—

Alumina, from	50 per cent to 60	per cent.
Ferric oxide, about	2.75	per cent.
Water, from	25 per cent to 30	per cent.
Insoluble matter, principally silica, about	7	per cent.
Titanic acid, from	2 per cent to 3	per cent.

This analysis shows the Cherokee ores to be of very fine quality. They carry, as said by the manufacturers, a somewhat smaller percentage of alumina than do the Baux, or France, ores with which they come in competition, but that they are more soluble, and hence are more valuable.

[1] An abstract of a paper prepared for the Fall Meeting, on Nov. 16, of the Alabama Industrial and Scientific Society.

[2] Since the above was written, it has been heard that Bauxite out-croppings have been found in two other places in Calhoun County, near Anniston.