THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE meeting of the American Association for the Advancement of Science was held this year at Portland, in the State of Maine, during the fourth week of August; there was a large attendance of well-known scientific celebrities and members. The following account, for which we are indebted to the *New York Tribune*, will give an idea of some of the most important papers and discussions.

A discussion on the Darwinian hypothesis, which was started by Prof. Swallow, who is a vigorous opponent, was continued by Dr. Dawson, who began by stating with some fullness of detail the demands upon our credence made by the advocates of the evolution theory. Among other requirements of the theory, he said, it must provide an explanation of the origin of life. To accomplish this the experiments of Bastian were brought forward. Referring to these, he stated that no less an authority than Prof. Huxley, though an evolutionist, had denied their conclusive character and disputed the alleged results. We are expected to admit, in every department to which scientific inquiry relates, that in all things there has been a successive progress from the lower to the higher. Why should we make this admission? What proof is there of it? The recent discoveries of embryology, showing the likeness of early forms of the embryo to other animals of the same families, furnished to the advocates of evolution no real argument in its favour. They proved nothing. Admit if you will the close resemblance of similar bones and general physical structure in the ape and man, it is not the slightest evidence of identity. While it may be true that there is bone for bone in monkey and in man, still it remains that the bones of one are different from those of the other. The making of monkey and of man is explicable quite as readily, to say the least, on the theory of plan as on that of evolution. The history of the growth of an animal has been cited as the evidence of a development from a lower to a higher form. But what are the facts in the case? The egg grows into the animal, and that organism produces an egg again. This is revolution, not evolution.

We are told to accept as a postulate that mind too is a result of development; that the moral as well as the material being is simply a consequence of the evolving process. I do not grudge the naturalists who have adopted such theories the intellectual exercise which is involved, but I regret that much of their labour is wasted, and the results will be burnt when the fires of truth are applied to the chaff they are accumulating. This is not a question of physics that they are arguing, it is one of metaphysics, and it would be well for our children as well as growing scientists if they were taught more of mental and moral philosophy as a basis for such inquiry.

But I thank the students who are thus engaged for some good results of their exertions. They have thereby succeeded in reducing the superfluous numbers of species, and have obtained far better views in respect to classification. Good results will also flow from the profound embryological researches of the day. But I am sorry for the investigators, for their reputations are at stake, and they have chosen a mistaken path.

We are, however, approaching in our studies a correct theory. After its appearance in geological history, every species has a plastic tendency to spread to its utmost limits of form. Then ensues a period of decadence until it may become extinct. This has been set forth in some of my printed memoirs on the plants of the carboniferous series. I believe that a similar process is true of the human race. He referred to the skull of Mentone and its finally developed character—a grandly developed man cerebrally and bodily. The burial of his dead testified to his religious belief. The people of the Cromagno skull age were of a similarly elevated character. The only point of difference from men to-day was in the flattening of one of the leg-bones. This was perhaps a result of the habits of the tribe, running through forests in pursuit of game. It begins to be admitted that the man of Western Europe came in with the modern mammalia at the close of the glacial period. This was a period of decadence, and when the pliocene fauna were dying out and new forms were taking their places. The most ancient form of man is beyond the average standard of modern humanity. If the man of Cromagno or Mentone had been sent to Harvard, he would have been graduated with the full honours of an average American student.

Prof. Morse stated that Dr. Dawson and Prof. Swallow had both misquoted Prof. Huxley, who had said, in respect to the ancient skull referred to, that it might have held the brains of a thoughtless savage, or it might have contained those of a philosopher. Dr. Dawson had referred to only the differences in those remains from those of the man of to-day in respect to the flattened tibia. There were, however, several other characters of a similar nature which Dr. Dawson had not referred to, some of which had been discovered by Prof. Wyman, and had not yet been published. In the existing races of man the *foramen magnum* (the large opening at the base of the skull through which the brain communicates with the spinal cord) exhibited very little change of position in its relation to the rest of the skull, while with the higher primates (apes) this opening is very near the posterior portion of the skull. In eleven ancient skulls from the shell heaps of Tennessee, the *foramen magnum* in every case was nearly an inch further back than in those of present existing races. The powerful muscles on the sides of the head that move the jaws leave a distinct line at their upper points of attachment. These lines are called temporal ridges. In all present existing races a space occurs on the top of the skull, between these lines, of from three-and-a-half to four inches. In the apes these muscles meet in the median line which rises into a bony crest so characteristic of the gorilla. There was a remarkable skull discovered by Prof. Wyman in the lowest beds of the ancient shell heaps of Florida. This has the temporal ridges approaching each other within a half inch at the top of the skull. If the high development of the skull referred to by Mr. Dawson was such as he states, it only carries man further back. Similarly, in the light thrown upon the history of man by the wonderful discoveries in archæology, where we meet with traces of an ancient civilisation, with complicated language and manners, we can surely believe in savage hordes pre-existing from which this ancient civilisation has been evolved.

As to the early traces of man, we must fully appreciate the rare possibility of their occurrence. Wherever you dredge in the waters of the present day the traces of man are among the rarest discoveries. The Lake of Haarlem, upon whose waters naval battles have been fought, and on whose shores a dense population has existed, was drained, and on its bottom not the slightest traces of man's existence were found. Prof. Morse dredged repeatedly for years off the shores of Maine, and no trace of man was ever brought up, except a single spike. When we consider how abundant the material for such remains must be now compared with those furnished by the simple methods of life and the sparse population of earlier days, the indications of man's existence in geological eras must be of the rarest occurrence. In fact, in such rocks as the drift, only the rude stone implements could be preserved.

The evolution theory as compared with that of special creation presented similar features to the undulatory theory of light as compared with the emission theory. Newton's theory required a new modification with every discovery in optics, until, as a writer said at that time, the emission theory is a mob of hypotheses. The undulatory theory of Young not only explained all that was difficult to Newton, but gave physicists the power of prevision. So with evolution. It not only accounts for existing phenomena, from the modification of a flower or the spot on a butterfly's wing to the genesis of the solar system, but it has endowed naturalists with the gift of prophecy and enabled them to predict the intermediate forms afterwards discovered in the records of the rocks.

On Calvert's Supposed Relics of Man in the Miocene of the Dardanelles. By G. Washburn.—The author reports, in view of the facts to which the paper refers, as to the flints, the split bones, and the marks upon the fossil bone, that he believes that Mr. Calvert and Sir John Lubbock (who had never seen the specimens) are mistaken in the conclusions to which they have come, and that they have not been able to find any evidence whatever at the Dardanelles in reference to the antiquity of man.

The Rotation of the Planets as a Result of the Nebular Theory. By Prof. Benjamin Peirce.—Prof. Peirce's paper set forth an explanation of the actual rotation of the planets on the supposition of their being formed according to the nebular hypothesis, from rings thrown off from the rotating main body in the process of condensation. He instanced more particularly the planets Jupiter and Saturn. The inner portions of such a ring having a less velocity than the outer ones, axial rotation in the same direction as that of the primary would be determined in the breaking up and running together of the ring into a planetary body. He showed, by a mathematical analysis of the movements of the particles com-

posing the ring, that the velocity of the resulting rotation must be such as is actually observed in the case of the planets referred to, whose mass represents nine-tenths of the whole planetary system.

In Jupiter and Saturn, the velocity of a particle in the planet is very nearly the velocity of the planet itself. Then Jupiter and Saturn must have derived their material from the whole mass of the planetary system. The best theories of the earth make it of uniformly decreasing density from the surface to the centre. Suppose that after Jupiter were formed it were condensed, that might otherwise explain its velocity. He showed that, in the case of the planets, the velocity, had it been one-half what it actually was, would have resulted in their having no rotation. This theory was applied to the absence of rotation in the case of our satellite. He showed the probability that the original nebular ring from which the planets were formed may have been of twice the size of their present orbits. The nebular theory, to meet the requirements of the mere mathematician, would have placed all the planets at regular distances, and given them exactly similar motion. But not such was the method of nature.

In the discussion which followed he stated that we have never seen anything of Jupiter or Saturn but the clouds which cover them. He thought that those planets were yet at a white heat, and we simply saw the clouds that are raining down upon them. The present state of the satellites may be a result of their tides, and not the index of their original velocity. Jupiter and Saturn took so large a proportion of all the planet-forming material that the laws impressed upon them may serve best to tell the whole history of the solar system. There may be, however, a rotation of the inner mass of those planets of which we know nothing.

Geology of Southern New Brunswick. By Prof. T. Sterry Hunt.—The recent labours under the Geological Survey of Canada, by Messrs. Bailey Matthew and the author, were sketched. They show south and west of the coal basin various uncrystalline formations, all resting upon ancient crystalline rocks. These latter are by the author regarded as for the most part the equivalents of the Green Mountain and the White Mountain series, or what he calls Hurordan and Montalban. These are penetrated by granites, and associated in one part with Norian rocks, but the presence of Lamentran is somewhat doubtful. While the author recognises thus, at least, four distinct series of pre-Cambrian crystalline rocks in Eastern North America, he does not question the possible existence of yet other series in this region. The analogies offered by the more recent rocks of this region are very suggestive.

On the Possibility that the Sun, while mainly Gaseous, may have a Liquid Crust. By Prof. Charles A. Young.—There can be very little doubt that Secchi and others, who hold that the sun is mainly gaseous, are correct in this: the smallness of density cannot possibly be explained on any other supposition. At the same time the eruptional phenomena which are all the time occurring on the surface, almost compel the supposition that there is a crust of some kind which restrains the imprisoned gases, and through which they force their way in jets with great violence.

Prof. Young suggests that this crust may consist of a more or less continuous sheet of descending rain, not of water, of course, but of the materials whose vapours exist in the solar atmosphere, and whose condensation and combinations are supposed to furnish the solar heat. As this tremendous rain descends, the velocity of the falling drops would be retarded by the resistance of the denser gases underneath; the drops would coalesce until a continuous sheet would be formed; and these sheets would unite and form a sort of bottomless ocean resting upon the compressed vapours beneath, and pierced by innumerable ascending jets and bubbles. It would have an approximately constant depth in thickness, because it would re-evaporate at the bottom nearly as rapidly as it would grow by the descending rains above, though probably the thickness of this sheet would continually increase at some slow rate, and its whole diameter diminish.

Prof. Young added an explanation of the narrow disc fringes seen at the moment of totality in a total eclipse, showing them to be optical interference effects caused by the sudden changes of the temperature of the air at the edge of the shadow. The twinkling of stars is analogous in many respects.

The Existence of Live Mammoths. By Prof. Feuchtwanger.—The discovery of the mammoths in Siberia in the deep gorges of the mountains near the Lena Viner, which was lately published as having been made by a scientific Russian convict, who had five living animals, twelve feet in height and eighteen feet in length, with projecting tusks four feet long, excites some discussion in Europe. I think it worthy of inquiry whether the mammoth of the past tertiary period, discovered during this century in Siberia, near the same river, can have any relation to the convict's discovery. Thousands of these animals have been found buried in the ice, with their well-preserved skins, and thousands of tusks are brought to England to this day for the use of the turner. These are of nearly the same dimensions as those seen by the Russian. The convict has received an unconditional pardon, on the recommendation of scientific men who have investigated his statements and believe them to be true.

Prof. E. S. Morse, of Salem, Mass., read a paper on the subject of *Variations in Wave Lengths.* Prof. Morse first called attention to the interesting discoveries of Lockyer, Huggins, and others in accounting for the displacement of lines in the spectrum in observations of celestial objects. It is well known that when a star is approaching the observer the luminiferous waves emitted by it are crowded together, and on the contrary are separated when the star is receding.

Mr. Morse brought forward an instrument by which this phenomenon in the case of light may be easily and plainly illustrated before a large audience. The instrument consists of a tank filled with water and set on wheels. On the top of this is a compartment containing compressed air. From one end of the tank a pipe protrudes, which is moved up and down at a fixed rate by simple clockwork. When the cock is opened, allowing the water to escape from the pipe, the stream assumes a sinuous line, which may be shown, if brilliantly lighted, across a large audience hall. This undulatory stream, when the tank is at rest, illustrates a luminiferous wave from a stationary source. To exhibit the shortening or lengthening of the waves of light by the approach or recession of the luminiferous body, Mr. Morse simply moves the apparatus rapidly back and forth on the table. As the apparatus moves with the direction of the stream its undulations are crowded together, and the waves are consequently shortened. On the other hand, when the motion of the apparatus is in an opposite direction, the waves are proportionably lengthened. The advantage of this illustration is that it exhibits precisely what takes place in the luminiferous waves approaching or receding from the observer of celestial bodies, producing the displacement of spectrum lines.

Concerning Hyalonema. By Dr. Samuel Lockwood.—The recent deep-sea dredgings have done much toward clearing up the singularly anomalous history of the Japanese glass-rope sponge. Prof. Lockwood, however, thinks that, either from inappreciation or otherwise, the knowledge thus obtained has not been applied to the elucidation of certain mooted points connected with Hyalonema. With regard to the mistakes in representing Hyalonema "wrong end up," my opinion is that the error was led off by the Japanese themselves. The drawings by the native artists represented these curious objects as attached to the sea bottom by the sponge mass, thus making the fascicle to be erect and uppermost. Obtained by the net, or some such means, from the bottom at great depths, it is supposable that the fishermen at Enoserma were entirely ignorant of the matter. Their theory, however, as represented by the native artists, has wrongly represented the Hyalonema. These ropes attached to the sponge and sand are some distance from the main or upper portion encrusted with parasites. After removing portions of the encrusting case from the fascicle, he could not detect any structural evidence that Polython owed anything for food to the object which had given it local support. It, however, "chums" with the sponge for a purpose of its own. Prof. Lockwood thinks that it draws sustenance from the fishing process of its radiating tentacles.

Both Polyps and sponge provide for themselves. In his view the zoöphyte is what we must call a compensal, and could not exist without that sort of support from Hyalonema which the oak affords the vine: and Hyalonema, too, is a compensal; for how long would it endure without the support of Polython? The stem, without this support, would not be able to hold itself erect. Other varieties are supported by stems consisting of sheaves of short spicules, bound together by bony cement. These have and need no supporting Polythoa. He combated the view that Hyalonema was sunk in the mud up to the neck, arguing that the polyps surrounding the stem could not so live; that it could not use its tentacles to obtain food, and that the position of the egg-cases of the deep-sea shark, the oldest egg being attached, and the most recent at the bottom, sustained this view. Some account was then given of the material structure of the encoating Polython. The essayist spoke of the deep-sea sharks off Setubol,

making that place their feeding-ground, because of the facility afforded them to secure these egg-cases by the abundance of the Hyalonemas there.

The Co-efficient of Safety in Navigation: an attempt to ascertain within what Limits a Ship can be located at Sea by Astronomical Observations. By Prof. Wm. A. Rogers.—This was an attempt to ascertain mathematically the average number of miles that a ship may be out of her reckoning. It was a paper of length, indicating long and careful research. It stated that in the case of British vessels there is a continual increase in the proportion of wrecks, as shown in the following:—

British vessels.	Wrecks.
Inc. 1858 over 1848.....38 per cent.	Inc. 1862 over 1852.....59 per cent.
Inc. 1868 over 1858.....44 per cent.	Inc. 1867 over 1857.....57 per cent.

For 1869 we have a decrease in the number of vessels of 4 per cent., and an increase in the number of wrecks of 21 per cent. The confidence in reckoning by instruments had increased the danger. He considered separately (1) wrecks by causes beyond control; (2) wrecks to obtain insurance; (3) wrecks by deviation of compass; (4) wrecks by errors of observation. He concluded that 70 per cent. of wrecks were from preventible causes. There are 3·3 times as many insured vessels wrecked as uninsured. The ratio of errors in chronometers wasillustrated in an elaborate series of tables showing that the navigator must expect from this source an error of 3·6 miles, must be on the look-out for one of 11·5, and must not be surprised at one of 21 miles, all on the supposition that he has an average chronometer. One serious source of error is varying temperature during a voyage. The conclusion was that the navigator who assumes that he can get the place of his ship certainly within five miles, or probably within fifteen, exhibits an over-confidence which may lead to his ruin.

There were other papers of interest, by Prof. Elliott, on International Coinage; by Prof. Wheildon, on the Arctic Regions; by Gen. Barnard, on the Relation of Internal Fluidity to the Precession of the Equinoxes; by Prof. Hilgard, on Transatlantic Longitudes, and on Meridional Arcs; by Col. Whittlesy, on Rivers in the Mississippi Valley; by Prof. Hunt, on Breaks in the American Palæozoic Series; by A. E. Dolbear, on a new method of measuring the velocity of light.

MR. HARTNUP ON DETERMINING THE RATES OF CHRONOMETERS*

THE difficulty in predicting the rate of a chronometer for a voyage arises from the imperfect state of the instrument; and by a well-arranged and carefully conducted test, these imperfections may be so exhibited as to enable the mariner to avoid the danger which must frequently follow from the neglect of such precautions. The Greenwich mean time is now so easily obtained in most seaports, that there can be no difficulty in ascertaining the daily gain or loss of a chronometer, if the rate so found could be depended on. The communication of time to the port of Liverpool, by the firing of the gun which is placed on the Morpeth Dock Pier Head, has been so successful that the difference between the flash of the gun and 1 P.M. Greenwich mean time has not, on any occasion during the past year, been such as could lead to an error in a ship's longitude to the extent of the width of the Mersey opposite the point on which the gun is placed; and by observing the flash of the gun on two occasions at an interval of a few days, the rate of a chronometer may be obtained with sufficient accuracy for most practical purposes. The rate so obtained might, however, differ very much from the rate at sea, if the temperature in which the rate was obtained in port differed much from that to which the instrument was exposed on the voyage.

Imperfect thermal adjustment is a defect so well known, that during the past thirty years the attempts made to improve the quality of marine timekeepers have been mainly confined to the compensation balance. The ordinary balance does not perfectly compensate for the change in the elasticity of the balance-spring, caused by change of temperature, and various forms have been given to balances with the view of attaining greater perfection. Balances have, without doubt, been made to compensate for change of elasticity in the spring throughout long ranges of temperature, but there is evidently some objection to their general adoption for the merchant navy. It is possible that the thinness of the laminæ, and peculiarity in the construction of balances which are made with the view of removing the defect above named, may render them less permanent in their action, and more liable to injury in the hands of a less skilful mechanic than the original maker; but however this may be, the ordinary balance seems to be almost universally used in the merchant navy. This having been found to be the case, about four years ago arrangements were made at the New Observatory for the trial of chronometers in three definite temperatures with the view of showing the amount of change in their rates due to error of thermal adjustment, and more than one thousand marine timekeepers have now been tested in 55°, 70°, and 85° of Fahrenheit. From a careful examination of the records of these tests there appears to be a definite temperature peculiar to each chronometer in which the instrument goes faster than in any other temperature, and as the number of degrees above or below this temperature of maximum gaining rate increases the chronometer loses in a rapidly increasing ratio. If we assume this law of variation to be that the change of rate is directly as the square of the number of degrees from the maximum gaining rate, the rates calculated on that assumption are found sensibly to agree with those obtained from observation; therefore, if we have the rate from observation for each of three definite temperatures, as given in my last two Reports, we can find, by computation, the correction for error of thermal adjustment due to any other temperature. In order to do this it is necessary to find—

T . . the temperature in which the chronometer has its maximum gaining rate,
R . . the rate at the temperature T, and
C . . the factor, or constant number, which multiplied by the square of any given number of degrees from T shows the amount of loss for that number of degrees.

The following example shows the method of calculating C, T, and R from the observed rates in 55°, 70°, and 85°:—

Chronometer, No. 727.

Rate in 55° = − 2·92 s . . . r
„ 70 = − 1·88 . . . r'
„ 85 = − 3·13 . . . r''

$r - r' = -1{\cdot}04 \ldots d$
$r' - r'' = +1{\cdot}25 \ldots d'$
$d - d' = -2{\cdot}29$
$d + d' = +0{\cdot}21$

$$C = \frac{2(d-d')}{30^2} = \frac{-4{\cdot}58}{900} = -0{\cdot}00509$$

$$T - 70 = \frac{d+d'}{C \times 60} = \frac{+0{\cdot}21}{-0{\cdot}3054} = -0{\cdot}69$$

$T = 70 - 0{\cdot}69 = 69{\cdot}31$

$$R = r' - (T - 70)\frac{d+d'}{60} = -1{\cdot}88 + 0{\cdot}69 \times 0{\cdot}0035 = -1{\cdot}878$$

From the preceding Examples

	Mean Daily Rate in 55°	in 70°	in 85°	C.	T.	R.
	s	s	s			
No. 727...	−2·92	−1·88	−3·13...	−0·00509...	69·31...	−1·88

Let N = any number of degrees from T, then the Rate at T ± N = R + C × N².

Required the Rate of No. 727 at 40°

Here N = 29·31 and N² = 859·08

Therefore the Rate at 40° = − 1·88 + (− 0·00509 × 859·08) = − 6·25.

The values of C and T remain the same for long periods; as a rule, they do not sensibly change so long as the adjustments are not altered, and the instrument remains in good condition; but R is more changeable, and should be redetermined on all favourable occasions. To find the change in R the rate must be first carefully found in some definite temperature. Suppose, for example, that at some subsequent time the rate of No. 727 was found to be − 2·13, instead of − 3·13, in 85°, then the rate at T would be − 0·88 instead of − 1·88; but it might not be convenient to obtain the rate in either of the temperatures in which the rates are given in the test, and then it may be found as follows:—Suppose the rate has been found to be − 1·55 in 81·5, then the rate must be computed for 81·5, on the assumption that R has not changed, and the difference between the rate observed and the rate computed will be the correction to be applied to R.

The computation is as follows:—81·5 − 69·3 or N = 12·2 and $12{\cdot}2^2 = 148{\cdot}84$.

* Extracted from the Report of the Astronomer to the Marine Committee, Mersey Docks and Harbour Board, for the year 1872.