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. Whittlesey, 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.

$$\text{Rate in } 55^\circ = -\overset{s}{2{\cdot}92} \ldots r$$
$$r - r' = -1{\cdot}04 \ldots d$$
$$\text{,,} \quad 70 = -1{\cdot}88 \ldots r'$$
$$r' - r'' = +1{\cdot}25 \ldots d'$$
$$\text{,,} \quad 85 = -3{\cdot}13 \ldots r''$$
$$d - d' = -2{\cdot}29$$
$$d + d' = +0{\cdot}21$$
$$C = \frac{2(d - d')}{30^2} = \frac{-4{\cdot}58}{900} = -0{\cdot}00509$$
$$T - 70 = \frac{d + d'}{C \times 60} = \frac{+0{\cdot}21}{-0{\cdot}3054} = -0{\cdot}69$$
$$T = 70 - 0{\cdot}69 = 69{\cdot}31$$
$$R = r' - (T - 70)\frac{d + d'}{60} = -1{\cdot}88 + 0{\cdot}69 \times 0{\cdot}0035 = -1{\cdot}878$$

From the preceding Examples

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

Let N = any number of degrees from T, then the Rate at $T \pm N = R + C \times N^2$.

Required the Rate of No. 727 at 40°

Here $N = 29{\cdot}31$ and $N^2 = 859{\cdot}08$

Therefore the Rate at 40° $= -1{\cdot}88 + (-0{\cdot}00509 \times 859{\cdot}08) = -6{\cdot}25$.

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.

Therefore, the rate at 81·5 = – 1.88 + (–0·00509 × 148·84 = – 2·64.

Observed rate in 81·5 = – 1·55. Computed rate in 81·5 = – 2·64. The losing rate at T must therefore be diminished by 1·09, making the newly found R = – 0·79 instead of – 1·88.

For any chronometer which has been allowed to remain at the Observatory for a period of five weeks the certificate of test issued with the instrument contains the necessary data for calculating the correction due to imperfect thermal adjustment.

THE WHITWORTH SCHOLARSHIPS

THE following Memorandum on the Whitworth Scholarships, prepared by Sir Joseph Whitworth, has been approved by the Lords of the Committee of Council on Education, South Kensington :—

1. The experience of the past competitions for my scholarships has proved to me the necessity of establishing rules which shall insure that the holders of scholarships shall devote themselves to the studies and practice necessary for mechanical engineering during the tenure of the scholarships.

2. To effect this I propose to the Lords of the Committee of Council on Education that as soon as possible, *i.e.* in the competition of 1875, every candidate for a scholarship should produce a certificate that he has worked in a mechanical engineer's shop, or in the drawing office of a mechanical engineer's shop, for two years consecutively. In 1874 six months' consecutive work only in the engineer's shop will be required. The candidate must be under 22 years of age.

3. The candidate for the scholarship will be examined in the appointed sciences; in smith's work, turning, filing, and fitting, pattern making and moulding, as already established, and the same marks will be awarded as at present.

4. In 1875 and the following years each holder of a scholarship appointed under these new rules will be required to produce satisfactory evidence at the termination of every year that he has made proper advances in the sciences and practice of mechanical engineering by coming up for an examination similar to that which is prescribed for the competition both in theory and practice.

5. The scholarships may be held for three years, but may be withdrawn at the end of each year if the scholar has not made satisfactory progress.

6. The number of scholarships in the competition of 1874 will be reduced from ten to six. Each scholarship will be of a fixed annual value of 100*l.*, together with an additional annual sum determined by the results of the progress made in the preceding year.

7. At the end of each year's tenure of the scholarship, the scholars appointed under these new rules will, as before stated, be examined in theory and in practice in the same manner as in the competition for the scholarships. On the results of this examination the following payments, in addition to the 100*l.* before mentioned, will be made among each year's set or batch of scholars :—To the scholar who does best in the examination, 100*l.*; to the second, 60*l.*; to the third, 50*l.*; to the fourth, 40*l.*; to the fifth, 30*l.*; and to the sixth, 20*l.*; provided that each scholar has made such a progress as is satisfactory to the Department of Science and Art, which will determine if the sum named, or any other sum, shall be awarded.

8. At the expiration of the three years' tenure of the scholarships under these new regulations a further sum of 300*l.* will be awarded in sums of 200*l.* and 100*l.* to the two scholars of each year's set or batch who have done best during their tenure of scholarship.

In this way it will be possible for the best of the scholars at the end of his period of tenure of the scholarship to have obtained 800*l.*, and the others in proportion.

9. The prizes under paragraph 7 will be awarded according to the total number of marks obtained by the students in practice and theory in the examination at the end of the year. The prizes under paragraph 8 will be awarded by adding together the marks obtained by the students at the end of each of the three years.

SCIENTIFIC SERIALS

THE current number of the *Zoologist* commences with a notice by the editor, of Mr. Lloyd's "Official Handbook to the Crystal Palace Aquarium." In an interesting historical sketch of the growth of aquaria, he divides its development during the last forty years into three eras, the earliest being the instructive, the second the poetic and fashionable, and the present the commercial. The early development of the aquarium is then entered into, the work done by Bowerbank, Daubeny, and Warington being fully described. This is followed by a review of Mr. T. J. Moggridge's work on Harvest-idea that these insects do accumulate seeds in store-houses for winter consumption is correct, contrary to the assertions of Kirby, Latreille, and other high authorities. What is very peculiar is that these seeds scarcely ever show any tendency to gering Ants and Trapdoor Spiders, in which the author, from a careful and painstaking series of excellent observations on the habits of ants, which are described in detail, shows that the old minate, though under apparently very favourable circumstances. —Mr. Cornish notes the occurrence of the following fish at Penzance :—The Black Fish (*Centrolophus pompilus*), the Sole-nette (*Monochirus linguatulus*), the Braize (*Pagrus vulgaris*), Bloch's Gurnard (*Trigla blochii*), and the Torpedo (*Raia torpedo*). —Mr. F. H. Balkwill, in reply to a critical note which appeared in this journal (NATURE, July 24, p. 252) on a paper by him in the *Zoologist* for July last, objects to his remarks being thrown into the general form; the fact that the forms and arrangements of teeth in vertebrates is practically infinite, being assumed by him. But that such is very far from being the case will be agreed to by all zoologists; the types and arrangements of teeth being extremely few in comparison to what they might be. The argument does not require, as Mr. Balkwill thinks, the proof of the statement that the teeth of the wombat, dog, &c., should be of low type and simple development, which they are not; and he may be assured that all "genuine Darwinists" are of opinion that when two not distant types of animal life are in a position to occupy new and separate regions, the fact that their food can only be obtained from two sources, namely, animal and vegetable tissues, invariably leads to their divergence in two directions only, that is, towards a carnivorous and a herbivorous conformation. Therefore the non-placental type, on occupying Australasia, as well as the placentalia in the rest of the world, have differentiated into flesh-eaters and vegetable-eaters, each having developed, by natural selection, organs suitable for procuring their accustomed diet. It is not therefore to be wondered at that these organs should present many points of similarity in the two main divisions of the Mammalia.

BARON VON MALTZAN gives in the second number of the *Zeitschrift für Ethnologie* for 1873, an account of his travels in Arabia, and points out the various causes which have opposed the advance of our knowledge of its interior. Amongst these religion has acted as the most powerful obstacle, the exclusiveness of the Islam faith having, in fact, so effectually closed the country to modern research, that there are still many spots of which nothing is known beyond what Ptolemy was able to tell us. Baron von Maltzan selected the most southern extremity of the peninsula, which is as yet a *tabula rasa* on our maps, for the scene of his explorations. He draws attention to the artistic skill exhibited by these people in statuary and carving, before they fell under the rule of their Mahomedan conquerors from Central Arabia, when all their earlier civilisation was rudely checked and their language superseded, while they were then also first driven to adopt a monadic mode of life. In spite, however, of amalgamation with central Arabian elements, the population of South Arabia still admits of division into two distinct peoples, the Sabäer and the Himyarites, the former of whom have light yellow skins, while the latter, whose name he derives from *Hamr*, red, are so dark-skinned as to be genrally classed amongst the black races. Baron Maltzan observed a curious physical character in the family of the Himyarite rulers of the Fodli, or Ozmani-State, many of whom, both males and females, had six fingers and six toes on both hands and feet. This peculiarity is looked upon by the people at large as a special mark of blue blood, and prized accordingly by the possessors. It would seem that the practice of forming consanguineous marriages, which prevails in the Fodli, as in other ruling houses, may of itself explain, as a mere case of hereditary recurrence, the appearance of this physiological character in numerous and remote members of the family. The author concludes his paper with an appeal to men of Science to turn their attention to a region which is at once so little known and so rich in materials of interest for physiologists, ethnologists, and geographers.—Herr von Martens, in a critique on Prof. Strobel's paper on the appearance of *Unio* shells in the pile-dwellings of Upper Italy