crystal, they often serve to determine the particular type of symmetry to which the structure belongs when polarised light may merely indicate whether the crystal is optically isotropic, uniaxal, or biaxal. Dr. Baumhauer has done a great service by preparing for publication a series of magnified photographs of the figures produced by etching different faces of crystals of the following substances:—Fluor, Blende, Cryolite, Apatite, Nepheline, Datolite, Zinnwaldite, Leucite, Boracite, Dolomite, Magnesite, Chalybite, Nickel sulphate, Strychnine sulphate.

The figure on the previous page shows the hexagonality of the depressions which, after etching, are seen on a basal plane of a crystal of Apatite.

These beautifully executed photographs are accompanied by detailed descriptions (85 pp.), and by a sketch of the history and development of the methods (46 pp.). Dr. Baumhauer has done such excellent work in this branch of science, that he is particularly qualified to select and describe examples which illustrate the potentiality of this mode of investigating crystalline structure. The photographs are mounted on twelve separate plates, so that they may be conveniently used in the classroom.

Summer Studies of Birds and Books. By W. Warde Fowler. Pp. 288. (London: Macmillan and Co., 1895.)

Forest Birds; their Haunts and Habits. By Harry F. Witherby. Pp. 98. (London: Kegan Paul, Trench, Trübner, and Co., 1894.)

IT would be difficult to find a worthier disciple of Gilbert White than Mr. Warde Fowler. Many of White's most exact and enduring observations were made on birds, and the "Natural History of Selborne" has furnished his imitators with descriptions of the characteristics of the Stone-curlew, the Ring-ousel, the House-martin, the Sand-martin, the Goat-sucker, and many more of the birds of which he recorded the habits and movements. But Mr. Fowler's writings are not mere paraphrases of his prototype's. He is gifted with the "nice observation and discernment" required by every student of nature; and he can express himself in attractive language—attractive because it is unaffected, and because it is devoid of thin sentiment and gush. The result is that the papers reprinted in this volume are really valuable contributions to ornithology. To remark that there is not a dull page in the book may be a trite saying; nevertheless, so far as we are concerned, it is a true one in this case. What could be more readable than the chapters on the birds of the Engstlen Alp, and the birds of Wales; and where will you find a better example of careful and painstaking observation than is afforded by the account of the Marsh Warbler in Oxfordshire and Switzerland? The chapter on the songs of birds is most interesting; that descriptive of Aristotle's writings on birds, (in which fact and fiction are given equal prominence), should be read by all naturalists; and the biography of Gilbert White shows that the author is saturated with the spirit of the naturalist whose work has had such a wide influence upon natural history during the last hundred years.

Little more need be said about this charming book. So many volumes on popular natural history have lately appeared, that the subject has probably begun to pall upon the public taste. Mr. Warde Fowler's work, however, is so full of interest; it breathes out the air of the fields and streams so pleasantly, that it carries its own welcome to the heart of every lover of nature.

The second of the two books of which the titles are given above, is of quite a different character from the first. It is remarkably well illustrated, is daintily bound, and is nicely printed, and therefore it forms an attractive volume, so far as appearances go. But the text is dull; for the author, while possessing the essential love of nature, lacks the words with which to express it eloquently. To him, "the Stock Dove is fourteen inches in length from the tip of the beak to the end of the tail, and its stretch of wing is twenty-six inches. Its general colour is bluish-grey. The head, wings, and back are of this colour, and the tail is the same, but tipped with leaden grey." There is much more of the same kind in the book; and we confess that after reading Mr. Warde Fowler's smooth phrases, Mr. Witherby's composition appears spiritless. The illustrations, however, are good enough to make up for deficiencies of the text, and for their sake alone, the book is worth buying.

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.*]

On the Age of the Earth.

IN reference to Lord Kelvin's letter (NATURE, January 3, p. 227), he will, no doubt, presently communicate with you on the results of measurements which he is making on conductivity and temperature in rocks. I do not wish to forestall him by referring at present to his more recent correspondence with me. Three weeks ago I sent him the solution of the problem of a cooling sphere whose conductivity k and volumetric capacity c are any functions whatsoever of the temperature v, but which are always proportional to one another. As Mr. Heaviside had been writing to me, and had shown me that under certain circumstances the differential equation became linear, and as I had used his *operators* much as he himself uses them, I cannot say to what extent I can claim credit for the work. I now venture to send you the more general case.

If

$$\int c \,.\, dv = u \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

so that u is the total amount of sensible heat in unit volume. The general equation is

$$\frac{d}{dx}\left(k\frac{dv}{dx}\right) + \frac{d}{dy}\left(k\frac{dv}{dy}\right) + \frac{d}{dz}\left(k\frac{dv}{dz}\right) = \frac{du}{dt} \quad . \quad . \quad . \quad (2)$$

Now let $k = c\kappa$ where κ is a constant, then

$$k = \kappa\frac{du}{dv} \text{ as } c = \frac{du}{dv},$$

and the equation becomes

$$\frac{d^2u}{dx^2} + \frac{d^2u}{dy^2} + \frac{d^2u}{dz^2} = \frac{1}{\kappa}\frac{du}{dt} \quad . \quad . \quad . \quad (3)$$

Any of the many problems that have been worked out on the distribution of u may be translated into temperature problems. Thus in a body before $t = 0$ let $u = u_1$ a constant everywhere, and after $t = 0$ let the surface have everywhere a constant $u = u_0$. Let the solution be

$$u = (u_1 - u_0)\mathrm{F}\,(x, y, z, t) \quad . \quad . \quad . \quad . \quad (4)$$

In the body before $t = 0$ let $v = v_1$ a constant everywhere, and after $t = 0$ let the surface have everywhere $v = v_0$ a constant, then if v is the temperature anywhere

$$\int c \,.\, dv = (u_1 - u_0)\int (x, y, z, t) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

so that a table of the values of $\int c \,.\, dv$ enables the temperature at any place to be calculated.

If $\frac{du}{dn}$ the rate of increase of u normally inward from the surface at any place, has been calculated, say that it is

$$\frac{du}{dn} = (u_1 - u_0)\mathrm{F}(x, y, z, t) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

as

$$\frac{du}{dn} = \frac{du}{dv} \cdot \frac{dv}{dn} = c\frac{dv}{dn}$$

$$\frac{dv}{dn} = g = \frac{u_1 - u_0}{c_0} F(x, y, z, t) \quad . \quad . \quad . \quad . \quad (7)$$

where g is the temperature gradient inwards from the surface, and c_0 is the value of c at the surface.

If c and k are constant everywhere, say c_0 and k_0, let us call the surface gradient g_0; then as $u = c_0 v + C$

$$\frac{g}{g_0} = \frac{1}{c_0} \frac{u_1 - u_0}{v_1 - v_0},$$

for the same place at the same time after cooling began.

As an example, let

$$k = k_0(av + 1),$$

and

$$c = c_0(av + 1),$$

and measure v on the Centigrade scale, c_0 and k_0 are the actual capacities and conductivities at 0° C.,

$$u = c_0(\tfrac{1}{2}av^2 + v + C),$$

so that

$$\frac{g}{g_0} = \frac{\frac{1}{2}av_1{}^2 + v_1}{v_1} = \tfrac{1}{2}av_1 + 1.$$

Thus if c and k increase s per cent. per 100 degrees Centigrade, and if $v_1 = 4000$, as

$$a = 10^{-4}s, \ \frac{g}{g_0} = \frac{s}{5} + 1.$$

In the cooling of Lord Kelvin's infinite mass with a plane face the time which elapses until a particular surface gradient is reached is inversely proportional to the square of the gradient. If the time taken on the assumption of constant c and k be called t_0, and if the time taken on the assumption that c and k increase s per cent. for 100 degrees is t, then

$$t/t_0 = \left(\frac{s}{5} + 1\right)^2$$

Suppose

$$s = 50,$$

then

$$t/t_0 = 121.$$

So that Lord Kelvin's age of the Earth would be multiplied by 121.

It must be understood that my conclusions (NATURE, January 3, p. 224) are really independent of whether R. Weber's results are correct or not. Lord Kelvin has to prove the impossibility of the rocks inside the earth being better conductors (including convective conduction in case of liquid rock in crevices) than the surface rocks. If, however, Weber's results, as quoted by me, are trustworthy, the above solution is what I take Lord Kelvin to refer to in the first paragraph of his published letter. In considering all such measurements as those of R. Weber, it must be remembered that the rocks at twenty miles deep are not merely at a high temperature, but also under great pressure.

January 30. JOHN PERRY.

Oceanic Temperatures at Different Depths.

THE question of the persistence or otherwise of the temperature of different strata of water beneath the surface of the oceans, is one upon which so few observations have been made, that it will probably be interesting to students of oceanic phenomena to publish in NATURE the results obtained at one spot in the Atlantic, at periods extending over as much as twenty-one years.

At a position about 200 miles west-south-west from Cape Palmas, in Africa, where the depth of water is about 2500 fathoms, and where on the surface the Guinea current is running to the eastward, the *Challenger* in 1873 and 1876, the *Buccaneer* in 1886, and the *Waterwitch* in 1894, have all obtained serial temperatures; the first three to a depth of 200 fathoms, the last to 150 fathoms.

The result is given in the following table, and illustrated by the diagram.

Comparison of Ocean Temperatures obtained at Different Times in or near the same position, viz. 5° 48′ N., 14° 20′ W.

Depth in fathoms.	*Challenger* temperatures, 19/8/73.	*Challenger* temperatures, 10/4/76.	*Buccaneer* temperatures, 5/1/86.	*Waterwitch* temperatures, 22/9/94.
Surface	79°·2	83°·5	85°·5	80°·0
10	—	83·2	82·5	78·0
20	—	70·0	79·6	—
25	72·6	—	69·0	75·2
30	—	62·6	65·9	69·2
40	—	60·0	60·8	62·8
50	62·5	59·2	58·8	60·2
60	—	58·5	—	—
70	—	57·8	—	—
75	58·8	—	—	58·8
80	—	57·1	—	—
90	—	56·5	—	—
100	56·2	55·9	56·1	57·0
110	—	55·2	—	—
120	—	54·6	—	—
125	54·1	—	—	—
130	—	54·0	—	—
140	—	53·3	—	—
150	52·2	52·7	—	52·5
160	—	52·1	—	—
170	—	51·4	—	—
180	—	50·8	—	—
190	—	50·1	—	—
200	48·3	49·5	49·0	—

Exact Positions and Observation Spots.

Challenger, 19/8/73 ...	Lat. 5° 48′ N. ...	Long. 14° 20′ W.
Challenger, 10/4/76 ...	5 28	14 38
Buccaneer, 5/1/86 ...	5 48	14 20
Waterwitch, 22/9/94 ...	5 48	14 22

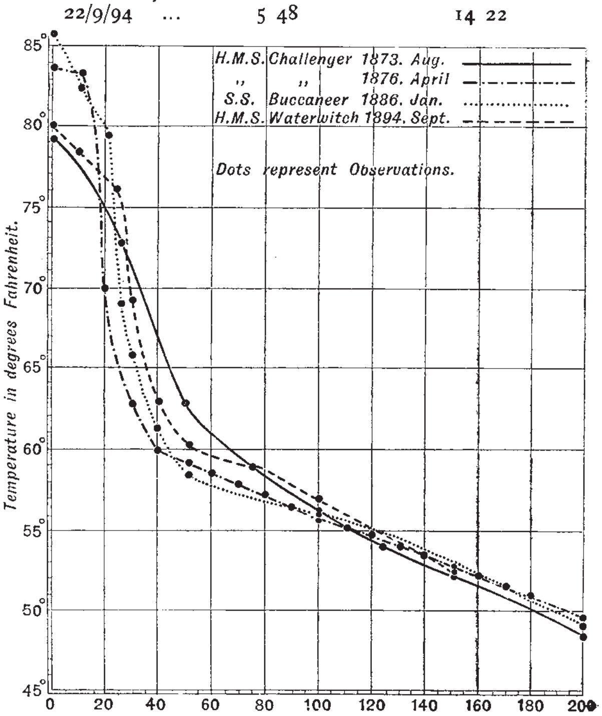

Diagram showing temperature at different depths obtained at various epochs in Lat. 5° 48′ N., Long. 14° 20′ W.

It will be observed that the temperatures at the surface vary by 6°·3 F.; at a depth of 20 fathoms, by 9°·6; at 40 fathoms,