They hold that the successive restorations of colour are due to fresh supplies of chromogen being produced by the plant under the influence of the hot water, and that each fresh amount is then oxidised to anthocyanin.

We suggest that these phenomena are explained by the fact that though a certain amount of pigment diffuses out into the water, a large proportion of that which was originally present is retained by the coagulated proteins of the petals, of course in the colourless state. It is the successive liberation of fractions of this retained pigment that accounts for the fresh production of colour in hot water, and not a new formation of chromogen.

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*On the Heat Production Associated with Muscular Work.**

By R. T. Glazebrook, M.A., F.R.S., and D. W. Dye, B.Sc.

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On reading Prof. Macdonald's paper it appeared that it might be interesting to see if his results connecting the heat production and muscular work could be expressed graphically or by means of some simple formula. The tables in his paper give the heat production in calories per hour of a number of individuals when doing a carefully measured amount of mechanical work on a kind of treadmill or cycle. This amount of work is kept constant for each group of observations in the paper. Table I gives his average results.

Table I.

	Mechanical work.	Heat production.	
		From observation.	From formula.
Group A	13	182	179
B	19	199	202
C	43	297	296
D	56	346	347

On plotting these as is done in fig. 1, it is clear that the points lie very approximately on a straight line, and it is easily seen that the equation to this line may be written

$$H = 128 + \frac{W}{0{\cdot}256}; \qquad (1)$$

* A Note on Prof. J. S. Macdonald's paper, *supra*, p. 96.

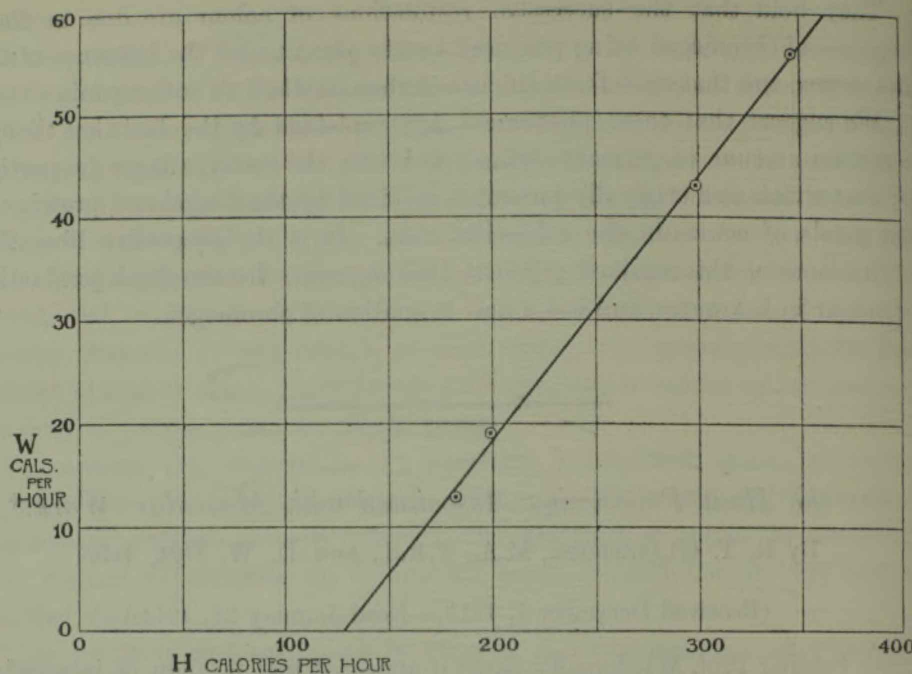

FIG. 1.—Relation between work W and mean heat produced H.

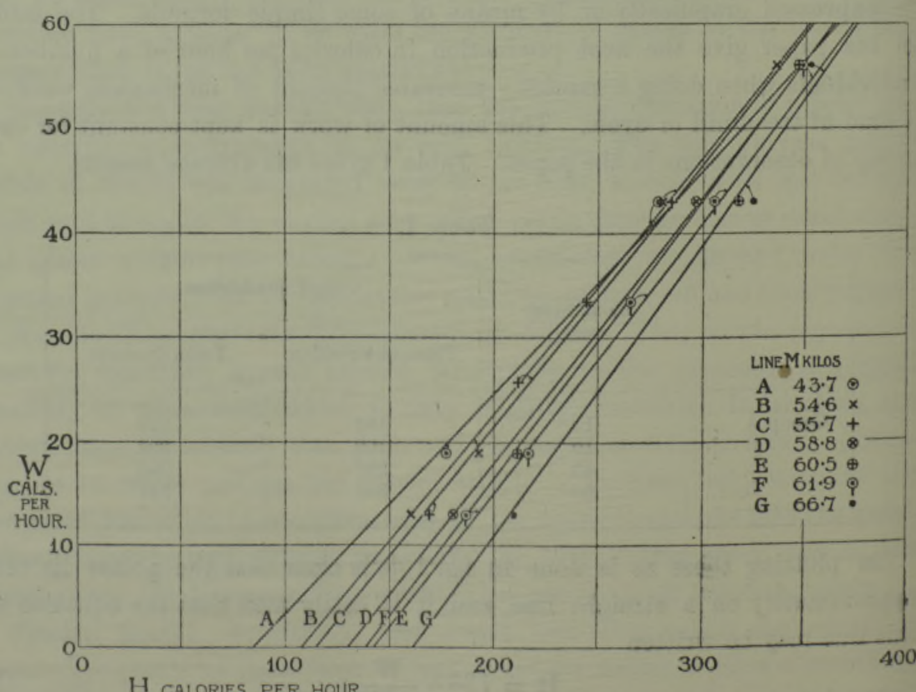

FIG. 2.—Relation between H and W for persons of various weights M.

or, more generally, $$H = H_0 + \frac{W}{\lambda}, \tag{2}$$

where H is the heat produced, W the work done, and H_0, λ constants which have on the average in Prof. Macdonald's experiments the values 128 and 0·256. H_0 is clearly the heat produced when the mechanical work done is zero, and arises from the motion of the limbs and the processes occurring in the body.

The fourth column of the table gives the results calculated from the formula.

But this is only an average result. It was clear from Prof. Macdonald's figures that the relation depended on the person doing the work, and we proceeded to plot the corresponding curves for the various individuals. These are shown in fig. 2; and though of course the number of observations is not

Table II.—Tabulation of Experimental Results (separated out in relation to the particular weights).

Weight, M.	Work, W.	Heat produced, H.	Measurements from curves fig. 2.	
			H_0.	λ.
kgrm.	Cals. per hour.	Cals. per hour.		
43·7	19 43 56	177 279 346	84	0·213
54·6	13 19 43 56	160 193 280 335	107	0·244
55·7	13 (26) (34·5) 43	169 (212) (244) 285	114	0·250
58·8	13 43	181 298	130	0·255
60·5	19 43 56	212 317 347	142	0·258
61·9	13 19 (34·5) 43 56	186 216 (265) 306 348	138	0·266
66·7	13 43 56	209 324 352	161	0·280

The figures in parenthesis are from a paper in 'Brit. Assoc. Rep.,' 1912, p. 286.

very large in each case for a given individual, the relation between heat and work is satisfied by a linear equation and can be expressed by the above formula, with the difference, however, that H_0 and λ depend on the individual and are not the same for all the persons tested. Table II gives the results and includes figures taken from an earlier paper in the B. A. Report for 1912.

The quantity λ measures the slope of the curve.

The next step was to investigate the relation, if any, between the quantities H_0 and λ and the weight of the man denoted by M and measured in kilogrammes. On plotting the values of λ against the mass in kilogrammes as is done in fig. 3, we found that the points again lay very well on a straight line and that the equation to this line was given by

$$\lambda = 0{\cdot}08 + 0{\cdot}003\,M. \tag{3}$$

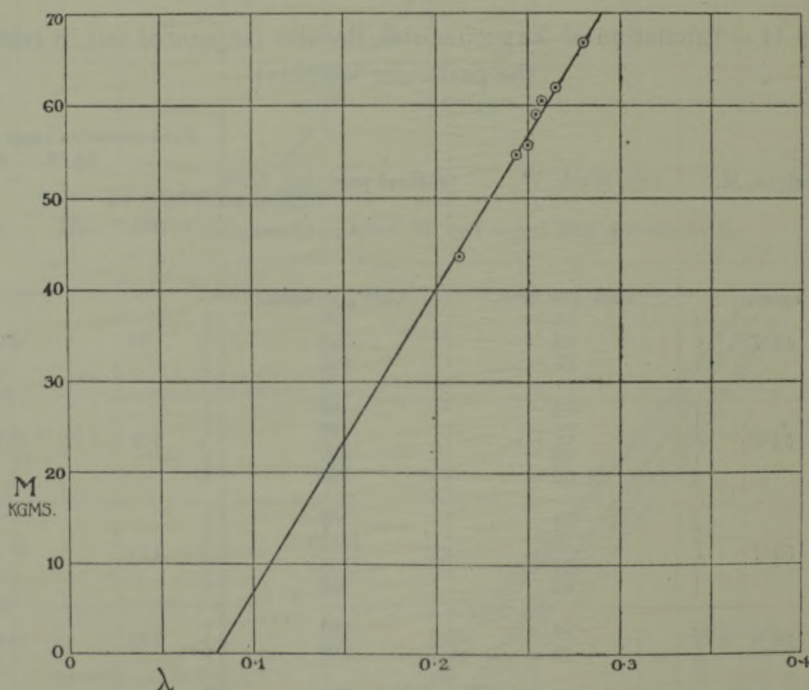

FIG. 3.—Relation between mass M and λ (slope of lines in fig. 2).

This quantity measures the ratio of the work done to $(H - H_0)$, the heat employed in doing this mechanical work, and for a man of 50 kgrm. weight has the value 0·23 or nearly one-fourth; the efficiency of such a man is about 25 per cent.

On plotting the values of H_0 against M as in fig. 4 we again found that a simple linear relation given by

$$H_0 = -138 + 4{\cdot}5\,M \tag{4}$$

satisfactorily held for all the points but one. Thus the heat a man generates by moving his limbs in a regular manner without doing external work is equal to the difference between 4·5 times his weight and a constant.

The one exception to the law was in the case of a boy weighing 43·7 kgrm. who had no experience of cycling and whose earlier experiments were omitted in consequence by Prof. Macdonald.

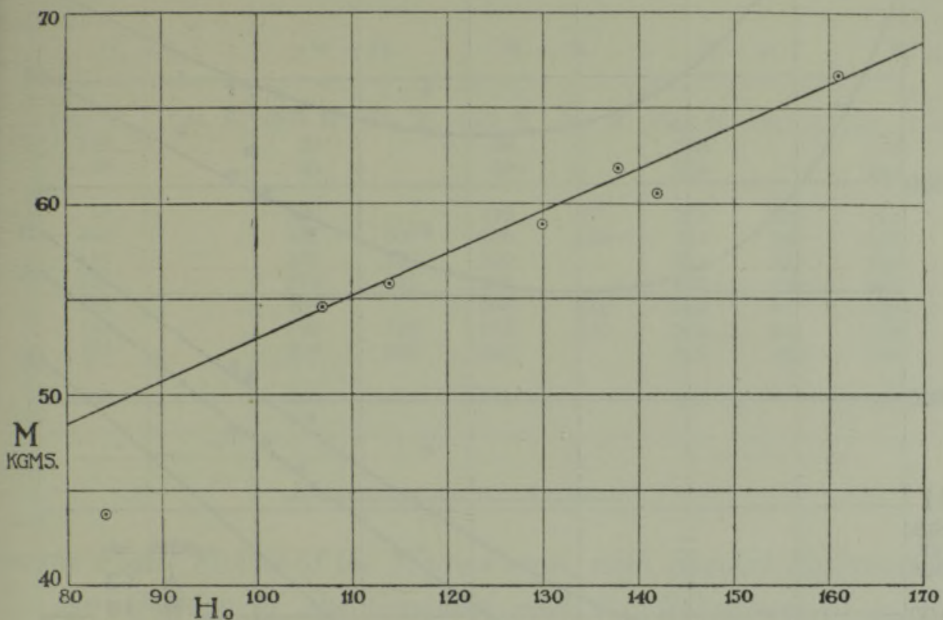

FIG. 4.—Relation between mass M and H_0 (pedals turning; no load).

If we now sum up the results, putting the values of H_0 and λ from (3) and (4) into our formula (2), we find

$$H = -138 + 4{\cdot}5M + \frac{W}{0{\cdot}08 + 0{\cdot}003M}. \qquad (5)$$

The curves obtained from this formula for different values of W are given in fig. 5, and the experimental results are there plotted.

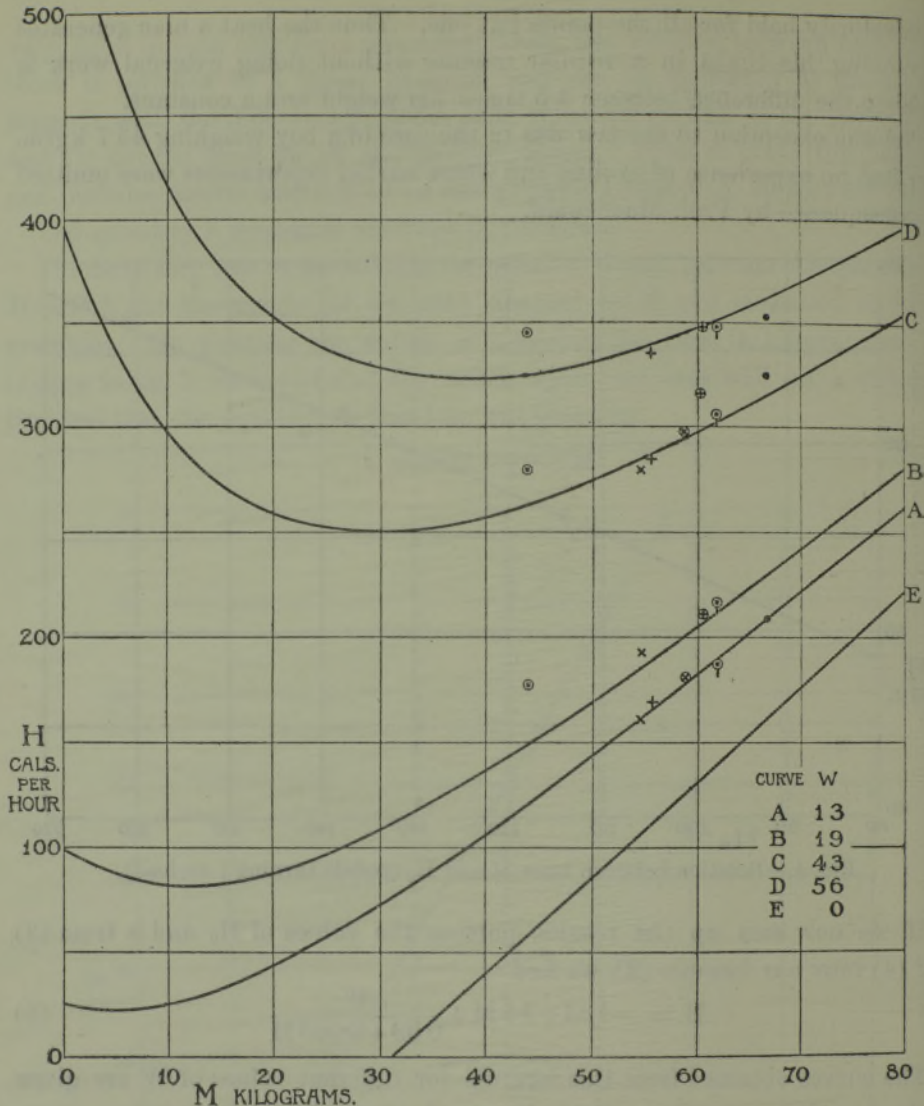

FIG. 5.—Relation between H and M calculated from equation (5).

The same results are tabulated in Table III. The differences between the results given by the formula and those found from observation are, with the exception of the boy of weight 43·7 kgrm., in no case large, and it would appear that the relation

$$H = a + bM + \frac{W}{\alpha + \beta M}, \tag{6}$$

where a, b, α, β are constants having for Prof. Macdonald's experiments the values given in formula (5), expresses, within the limits of experimental error, the relation between the work done, the heat produced, and the weight of a man. It is clear of course that the equation cannot be pressed too far; as to the value of the result found, we do not feel ourselves competent to judge. The work may, however, be of interest as an example of the analysis of somewhat complex experimental results by simple graphical methods.

le III.—Calculated Values of H by Equation (5) for the various Constant Rates of ork, W, used in the Experiments, and the corresponding Observed Values of same.

ass.	W = 0.		W = 13.		W = 19.		W = 43.		W = 56.	
rm.	Calc. H_0.	Obs. H.	Calc. H.	Obs. H.	Calc. H.	Obs. H.	Calc. H.	Obs. H.	Calc. H.	Obs. H.
0	−138		24		99		398		562	
0·0	− 48		45		88		259		352	
3·7	59		120		149	177	263	279	319	346
4·6	108		161	160	186	193	284	280	338	335
5·7	113		166	169	190		287	285	340	
8·8	127		178	181	201		295	298	346	
0·5	134		184		206	212	299	317	348	347
1·9	141		190	186	212	216	303	306	352	348
6·7	162		208	209	230		315	324	362	352
0·0	222		263		281		356		397	

On the Fossil Floras of the Wyre Forest, with Special Reference to the Geology of the Coalfield and its Relationships to the Neighbouring Coal Measure Areas.

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(Abstract.)

In the absence of any detailed knowledge of the geology of the Wyre Forest Coalfield, the area may be temporarily sub-divided into four regions. Fossil floras are described from three of these: from the horizon of the Sweet Coals in the Highley area in the north, from the unproductive beds of the Dowles Valley in the centre, and from the horizon of the Sulphur Coals of the Southern or Mamble area. On the evidence of the plants the Sweet Coal Series is shown to belong to the Middle Coal Measures, while the Sulphur Coal Series, overlying the Sweet Coals unconformably, belongs to a higher horizon, the Transition Coal Measures. The Dowles Valley unproductive measures are shown to be Middle Coal Measures, which are there over 1000 feet in