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Dr. R.D. Thomson & Mr. Edward T. Wood

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of heat, whether we suppose the pressure equal in all directions, or adopt any other hypothesis. Accordingly, when we adopt the equations which are obtained on the usual theory, and suppose the initial condensation and initial velocity given arbitrarily as functions of r , no contradiction is arrived at, either in the general case (see *Phil. Mag.*, vol. xxxiv. p. 55, paragraph marked 2), or in the particular case which might seem beforehand most favourable to the contradiction (see paragraph 3), as might have been confidently anticipated, inasmuch as one truth cannot contradict another.

Pembroke College, April 12, 1849.

LI. *Note on the Composition of Shea Butter and Chinese Vegetable Tallow.* By Dr. R. D. THOMSON and Mr. EDWARD T. WOOD*.

SHEA Butter.—This substance is a vegetable product of Western Africa, and was brought into notice by the celebrated Mungo Park during his journey in 1796. The tree from which it is procured he describes as very much resembling the American oak, and the fruit (from the kernel of which, being first dried in the sun, the butter is prepared by boiling the kernel in water) has somewhat the appearance of a Spanish olive. The kernel is enveloped in a sweet pulp under a thin green rind, and the butter produced from it, besides the advantage of keeping the whole year without salt, is whiter, firmer, and, according to Park, of a richer flavour than the best butter he ever tasted made from cows' milk. The growth and preparation of this commodity seem to be among the first objects of African industry, and it constitutes a main article of their inland commerce. This butter is abundantly produced, not only towards the Gambia, but also in the countries adjoining the Niger, as it is mentioned by the Landers and other recent travellers. Mr. John Duncan, who penetrated by Dahomey, describes the tree as resembling a laurel, and growing to the height of eighteen or twenty feet. The leaf is somewhat longer than the laurel and a little broader at the point. The nut is of the size and form of a pigeon's egg, and of a light brown colour; the substance of the shell about that of an egg. The kernel when new is nearly all butter. The shell is crushed from the kernel, which is also crushed and boiled with a little water in a pot for half an hour; it is then strained through a mat, when it is placed in a glass

* Read before the Philosophical Society of Glasgow, April 26, 1848.

bag and pressed. A good sized tree will yield a bushel of nuts.

Shea butter appears to be the same as that which is called Galam butter, and is derived from a species of *Bassia*; but the species has not yet been made out, as no specimens of the flower and fruit have reached botanists. The oil upon which the following experiments were made was obtained through the kindness of Dr. Carson of Liverpool, from Mr. Jameson, formerly of this city and now of Liverpool, whose benevolent exertions for the improvement of Africa are so well known. The colour of the oil is white with a shade of green. It is solid at the usual temperature in this country; at 95° it assumes the consistence of soft butter, and at 110° is a clear and liquid oil. When boiled in alcohol the greater part is dissolved, and crystallizes on cooling in needles: it dissolves in cold æther, and separates in needles by evaporation. The oil was saponified by means of caustic potash in a silver basin; the soap separated from its solution by common salt and decomposed by tartaric acid. After being crystallized out from alcohol five or six times, and freed by pressure from adhering oleic acid, the acid was obtained in fine pearly scales fusing at 142° : it was united with soda, and yielded a salt in fine pearly scales. Its atomic weight was estimated by means of the silver salt. In the first, second and third experiments, the silver salt was formed by precipitating an aqueous solution of nitrate of silver by an aqueous solution of the fatty acid united to soda. In the fourth and fifth experiments, an alcoholic solution of the acid was precipitated by a solution of nitrate of silver in alcohol, and hence the excess of acid.

I. 3.73 grains of silver salt gave 1.05 metallic silver = 1.126 oxide of silver = 30.19 per cent. AgO.

II. 10.65 grains of silver salt gave 3.01 silver = 3.221 oxide of silver = 30.23 per cent. AgO.

III. 2.85 grains gave .861 AgO = 30.21 per cent.

IV. 4.71 grains gave 1.30 silver = 1.394 AgO = 29.53 per cent.

V. 2.72 grains gave .743 silver = .797 AgO = 29.30 per cent.

The following table will express the per-centage composition of the silver salt by these five experiments:—

	I.	II.	III.	IV.	V.
Acid	69.81	69.77	69.79	70.41	70.70
Oxide of silver .	30.19	30.23	30.21	29.59	29.30

Taking the mean of all these experiments, the constitution of the silver salt will be—

Acid	70.10
Oxide of silver .	29.90

and the atomic weight of the anhydrous salt is—

Acid	33.97
Oxide of silver .	14.50
	<hr/> 48.47

or leaving out the two last determinations, we shall have as a mean for the three higher results the atomic weight of the acid equal to 33.82. To determine the composition of the anhydrous acid, the three following analyses were made by means of oxide of copper and chlorate of potash. :—

I. 2.85 grs. of silver salt gave	HO=2.30 grs. and	CO ₂ =5.73 grs.
II. 3.91	=3.39 ... =7.87 ...
III. 3.667	=3.058 ... =7.334 ...

The following table gives the composition of the above salt in 100 parts :—

	I.	II.	III.	Mean.	Anhydrous acid.
C	54.73	54.88	54.54	54.71	77.83
H	8.94	8.78	9.22	8.98	12.77
O	6.12	6.75	6.94	6.60	9.40
AgO	30.21	29.59	29.30	29.71	

From the facts which have been stated in reference to the acid contained in the shea butter, it is obvious it is margaric acid, the same substance which is found in the human fat and in butter. There is little doubt that on examination this acid will be found extensively distributed in the vegetable kingdom: its presence in the shea butter may assist in explaining the statement of Park, that this substance when fresh is equal in taste to butter.

Chinese Vegetable Tallow.—This is a solid oil, long known to those who are acquainted with China, where it is extensively used for making candles. It is derived from the seeds of *Stillingia sebifera*, which, according to Fortune (*Wanderings in China*, p. 65), are pulled in November and December. They are placed in a wooden cylinder with a perforated bottom over an iron vessel filled with water, which is boiled and the seeds well-steamed to soften the tallow; in ten minutes they are thrown into a large stone mortar, and beat with stone mallets to separate the tallow from the other parts of the seed: the tallow is thrown on a sieve heated over the fire and sifted, and is then squeezed out by a peculiar process. As imported it is a hard, white, solid oil, with a green shade. It fuses at about 80°. The oil was saponified, and the acid separated and purified according to the method already noticed. A soda salt was formed, and from this a silver salt was precipitated. 14.38 grains of this salt when burned left 4.03 grains of me-

tallic silver, which gives the following for the composition of the salt:—

		Atomic weight.	Per cent.
Oxide of silver	. 4.328	14.50	30.03
Acid	. . . 10.052	33.67	69.97

The acid was not quite pure; for when heated it softened at 143° , became very soft at 149° , of the consistence of cream at 150° , and quite fluid at 154° ; it obviously therefore retained some stearic acid, but must have consisted principally of margaric acid, as stearic acid fuses at 167° . There is no doubt that both of these oils might be advantageously employed in soap-making, the supply apparently, from the statements of the traders, being unlimited.

LII. *Determination of the Velocity of Sound on the principles of Hydrodynamics.* By the Rev. J. CHALLIS, M.A., F.R.S., F.R.A.S., Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge*.

IN conformity with the intention expressed at the close of my communication to the Number of the Philosophical Magazine for last February, I propose now to exhibit collectively the whole course of the mathematical reasoning by which I obtain, entirely on hydrodynamical principles, a value of the velocity of sound closely agreeing with that found by observation. The importance of the result, and the novelty of the considerations on which it depends, will be my excuse for going through the reasoning somewhat in detail, and for repeating some parts of previous communications. It may be proper to state at once, that I do not regard as defensible, or pertinent, all that I have written in the course of this difficult investigation; for instance, I have found that the new hydrodynamical equation, the necessity of which I have elsewhere insisted upon, is not, as I supposed, essential to the present inquiry. My immediate object is to extract and put in logical order what is really legitimate and essential.

The problem to be solved is, the numerical determination of the velocity of sound from the equations of hydrodynamics. As this may be considered to be a case of small vibrations, powers of the velocities and condensations above the first will be neglected. The pressure (p) being such that $p = a^2(1 + s)$, and u, v, w being the resolved velocities at the point xyz and at the time t , the equations applicable are the following:—

* Communicated by the Author.